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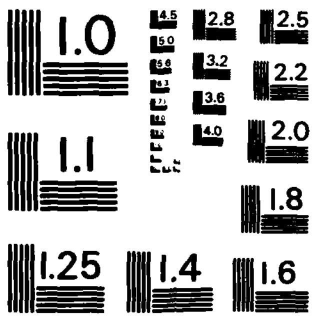

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THE IMPACT OF ALTERNATIVE TARIFF RATES

ON MILITARY AIRLIFT COMMAND REVENUES

THESIS

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AFIT/GLM/LSM/84S-9

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THE IMPACT OF ALTERNATIVE TARIFF RATES ON MILITARY AIRLIFT COMMAND REVENUES

THESIS

Presented to the Faculty of the School of Systems and Logistics

of the Air Force Institute of Technology

Air University

In Partial Fulfillment of the

Requirements for the Degree of

Master of Science in Logistics Management

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September 1984

Acknowledgements

Sincere gratitude is extended to all those people who have so willingly supported and assisted with this effort. Our thanks go out to the HQMAC/ACIB staff for the continuing interest and efforts in supplying us with needed information and historical data. We would also like to thank Mr. Barry Boettcher, the AFIT School of Systems and Logistics librarian, for his invaluable help, and our typist, Mrs. Stephanie Allen for her patience and attention to detail. Last but not least, our appreciation goes out to Lt. Col. James Annesser, who originated the idea for this study, and to our advisor, Dr. Leroy Gill, without whose guidance and understanding this thesis could not have been possible.

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Abstract

This research effort investigated the relationship between Airlift Services Industrial Fund (ASIF) tariff rates and the resulting demand for Military Airlift Command (MAC) services in regard to channel airlift. Emphasis was placed on the economic theory of price elasticity of demand to estimate what effect different tariff rates could have on total revenue.

The analysis was accomplished using a multiple regression model and historical data from the period 1976 to 1983, inclusive. Both a linear and a log/log variation of the model were used to establish the relationship between the price of MAC airlift and the actual ton-miles of cargo transported by air. This relationship was found to be inelastic up to a five percent increase in the 1983 real tariff rate. Once the estimated demand curve was established, conclusions on the continued use of current ASIF policy were discussed in light of the increase in organic capability MAC is expecting to experience in the next fifteen years.

THE IMPACT OF ALTERNATIVE TARIFF RATES
ON MILITARY AIRLIFT COMMAND REVENUES

I. Introduction

An important element of the MAC charter is the effective and economical management of DoD peacetime airlift capability. This valuable resource is comprised of the airlift capacity generated by war readiness training performed on military aircraft and the commercial augmentation available through civilian airline contracts to fulfill the airlift requirements of DoD agencies. As the Executive Director of the Single Manager Operating Agency for Airlift Service, the Commander of the Military Airlift Command is charged " . . . with the global mission to provide and maintain a viable military airlift system" (24:1).

Since 1958, MAC has managed the operation and maintenance of this airlift system through use of the Airlift Services Industrial Fund (ASIF). A revolving fund, the ASIF uses a tariff system to allocate airlift services to DoD elements.

Key to the operation of the ASIF are the forecasted training requirements of C-130, C-141, and C-5 crewmembers which are the basis of MAC aircraft operating levels (as opposed to peacetime airlift demand). These training requirements, known as Flying Hour Programs (FHPs), are one of the key cost elements in the tariff rate, driving the fuel and maintenance costs that will be incurred by the fund.

The airlift service tariff rates are determined by dividing the services total ton-miles into the forecasted annual operating costs of the system (minus the net operating position of the ASIF for the previous year). In this manner, the ASIF has historically strived to set reimbursement levels at a point that would achieve a zero profit/loss position at year end and over time.

An additional operating cost of the airlift system, totally divorced from the FHP issue, is the price and quantity of airlift generated by the Civil Reserve Air Fleet (CRAF) incentive programs. Due to the nature of the CRAF/DoD arrangement and the current use of DoD contracts as an incentive for CRAF participation, use of commercial contracts in any period where DoD organized airlift is not fully utilized raises the total cost to operate the airlift system. Since commercial contracts are included in the base for tariff determination, they increase the total cost of operating the system. Given that current estimates indicate that more than sufficient organic capacity exists to meet peacetime demand, the inclusion of DoD CRAF contracts in the tariff computation spreads an increased cost base over a relatively constant ton-mile demand for any particular year.

The delegation of demand to a position subordinate to that of training does not allow the system to respond to changing requirements in an economically responsible manner. For example, some factors may cause an increase in the required FHPs in a given year. If demand does not increase in the same period, increased system costs will be spread over a constant tonnage level, thus causing an increase in the tariff rate the next year.

A similar case could be made for increases in CRAF participation in DoD airlift, or an increase in the negotiated CRAF commercial tariff rate, either of which would serve to drive the total system cost, and hence the tariff rate, upward.

Recognition of these problems has stimulated attempts to keep the ASIF tariff comparable with commercial carrier rates. Efforts in this area have mainly revolved around the use of Operations and Maintenance (O&M) funds to partially offset the cost of system operation. Most notable has been the O&M funding of that portion of the C-5A's allowable cabin load that has been weight restricted due to wing defects. However, with the C-5A wing modification now in progress and due for completion in 1987, it is questionable whether Congress will continue to authorize O&M funds to minimize the cost of operating the airlift fleet.

Since the end of the Vietnam conflict, a combination of inflating costs, reduced military budgets, and increased organic and commercial capacity (without a proportional increase in demand) has caused the tariff charged to the user to steadily increase (even after adjusting for inflation). Current Air Staff programming includes the increase of organic capability to approximately twice that of the present by the late 1990s.

Problem Statement

Since DoD can presently satisfy peacetime airlift requirements, and since the ASIF tariff rates are built on the availability of capacity resulting from the flying hour program, an increase in present capacity might well effect the MAC tariff rate as well as the contracted tonnage offered to commercial contractors.

The objective of this research will be to answer the question of how the changes in MAC tariff rates, due perhaps to the projected increases in airlift capacity and associated training and operational cost increases, may affect the current Military Airlift Command Airlift Services Industrial Fund. The authors feel that a study of the effect of increased tariff rates on MAC revenues is long overdue.

In this thesis, Chapter II will cover the pertinent history and background information for a complete understanding of the research problem. The chapter will include both the history of Military Airlift Command and the development of the Airlift Services Industrial Fund concept as well as the

MAC/Civil Reserve Air Fleet interface. Chapter III is a synopsis of the methods that were used in the formulation of the regression model and Chapter IV presents the data from the developed model and analyzes the results from applying the model. The fifth and final chapter gives the authors' conclusions about the model and its effectiveness in predicting the effects of various pricing policies that could be adopted by MAC. This last chapter also includes some recommendations for future follow-on studies.

II. Military Airlift Command and the Airlift Services Industrial Fund

The mission of Military Airlift Command (MAC) is to maintain the ability to transport military forces and their equipment in strategic and tactical deployment and resupply of worldwide operations in support of national objectives. As the single manager for DoD airlift, MAC is responsible for maintaining sufficient capacity and capability to support these objectives. This capability includes aircraft, personnel, and facilities which must be positioned around the world to meet contingency air movement requirements for all of the services (25:22).

To meet these requirements, MAC has combined the use of organic and obligated commercial assets. This planned combination with commercial assets during contingencies is intended to minimize the costs of maintaining wartime capability in times of peace. To maintain this capability, MAC must sustain a specific level of flying, thus assuring proper training of aircrew and support personnel. Included in these requirements is the training of personnel along a worldwide route network, which is necessary for complete contingency preparedness.

To provide this training and thus ". . . maintain an adequate emergency readiness posture, MAC has developed minimum peacetime flying hour programs (FHP) for the C-130, C-141, and C-5 aircraft" (27:III-1). These FHPs subsequently produce cargo lift capability for military cargo, and the FHP projections, along with projected service movement requirements, are the basis of Airlift Services Industrial Fund (ASIF) rate-making to finance the flying program (27: II-1).

History of MAC and CRAF

On 1 December 1956, in accordance with DoD Directive 5160.1, the Air Force was designated as single manager for military airlift services and the Military Air Transport Service (MATS) was named the single manager operating agency for airlift services (16:II-2). This move was the result of the realization by military planners of the possible strategic capability of long-range airlifters. Due to technological limitations in the aircraft industry, it was not until the early 1960s that the capability became available to actualize these realizations, and provide the military a true long-range strategic airlifter, the C-141 Starlifter.

By 1966, a growing realization by Congress and DoD planners that ". . . airlift capability, both strategic and tactical, was of a degree of importance far exceeding a support function and when properly organized and administered was very much a weapon system in its own," manifested itself in the redesignation of MATS into the Military Airlift Command (MAC) (14:36).

This change in name and authority had, in part, been brought about by President John Kennedy when he changed national strategic policy from nuclear retaliation to flexible response. In light of this new strategic policy, the mobility mission of the Air Force took on new dimensions (11:41). Where the C-130 and C-141 aircraft had been built around the requirements and needs of an airborne division, new long-range aircraft would have to be designed to strategically project combat forces and their equipment, other than just airborne divisions, into hostile battle zones. This new policy of flexible response, in addition to the increasing technology of the day, gave rise to the C-5A Galaxy aircraft (30:38).

The stratagem of strategic mobility and its cardinal component, airlift, grew in importance in the late 1970s with the formation of the Rapid Deployment Force by President Carter. Since 1980, the Reagan administration has revised the strategy for deterring or, if necessary, fighting a conventional war, and has added greater visility to the case for increased airlift capability. "At the core of this new strategy is the concept of selective U.S. counter-offensives carried out at a time and place unanticipated by the Soviets or their surrogates in order to make the price of aggression greater than the aggressor might be willing to pay" (36:174).

Concurrent with the development of the concept of strategic mobility and long-range airlifters was the development of the commercial airlines. Although civil aircraft had augmented the military in World War II, it was not until the Korean War and the Berlin Airlift that the true value of this resource was realized.

As the result of a specially appointed committee by President Harry S. Truman, the Civil Reserve Air Fleet (CRAF) Program was formally established in 1952 (7:8; 6:25) to formalize the manner in which civil air carriers would support the military in times of national contingency. Although many changes have taken place in the program since its inception, the greatest concern to this study is the 1963 decision to tie DoD contracts for civil air shipments to commitment to CRAF participation.

The new practice combined MAC peacetime airlift procurement with standby mobilization contracts with the intention of increasing civilian airline participation in CRAF and of ensuring a healthy civil carrier base.

During Vietnam, both organic and civilian cargo capacity grew increasingly larger in response to need (30:42; 29: II-3); however, with the end of the conflict, there was a huge decline in DoD international shipments. This decline was a severe blow to the civil carriers (40:29) and, when combined with the sluggishness of the economy at that time, it caused many carriers to fall into bankruptcy (18:22). Although this drastic drop in traffic offered to the civil carriers was partially caused by a reduction in the number of troops stationed overseas, the major reason has been the MAC tendency to more efficiently use the by-product organic capability resulting from readiness training. The use of these MAC aircraft is more economical than contracting for civilian carriers to haul cargo which can easily be handled in-house.

History and Background of the Airlift Services Industrial Fund

In 1958 it was recognized that airlift services as provided by MAC fit the criteria for industrial funding and the ASIF was established. Since that time, the ASIF has continued to be the financing method of choice, and has been used "for allocating airlift capacity among the DoD departments--the airlift users" (29:ES-1).

As originally conceived, ASIF funding was based on the flying hours necessary to maintain a required state of readiness mandated by HQ MAC, with Air Staff approval. The rates under the ASIF were set by the Office of the Assistant Secretary of Defense-Comptroller Division (OASD(C)) one month prior to the beginning of the fiscal year. The tariff was computed from the MAC submission of the estimated cost of satisfying all of the services' forecasted mission requirements that were not funded directly by MAC's O&M budget (27: III-2, III-6).

This program set as a baseline the airlift ton-miles generated by the FHPs less the ton-miles generated by local exercise flying which generated no airlift capacity. The tariffs were set at a level that would cover forecasted operational expenses but were not planned to exceed them, thus causing the fund to have a zero balance at the end of the year. Once set, the tariffs were paid by all organizations transporting personnel or cargo through the military pipeline by organic or contracted airlift, and these revenues were used to replenish the working capital account.

Under the "revolving fund" concept, free transportation had been eliminated and the realistic costs of air transportation had been passed to the users. Thus, the objective of the ASIF to promote both efficiency and economy in providing airlift services was achieved (24:14). In addition, the working capital method of funding was implemented to allow a closer quantification of the costs incurred by the DoD airlift system (2:1). After this system was put into effect, a number of advantages, as well as disadvantages, were discovered.

Four major advantages to the industrial funding of MAC became apparent soon after the system was implemented: identification of inefficiences in the airlift system, increased user cost awareness, increased dollar flexibility for responding to fluctuations in user requirements (a flexibility not found under O&M funding), and a requirement that forecasters project their needs further in advance for budgeting purposes (27:IV-1).

The first advantage was the requirement to implement a comprehensive cost accounting system which provided MAC with a management tool for identifying inefficient and expensive procedures in the airlift system. The result was a reduction of the overall costs of operation, thus decreasing the projected expenditures and, consequently, the next year's tariff rates.

Having users pay for airlift space increased awareness of system costs and caused them to be more selective when deciding what should be transported as air eligible cargo. "The cost of transportation could now be considered along with such things as operational urgency, convenience, and the costs associated with storage, handling, and other logistics functions . . . " (6:39).

Increased flexibility in operations was also noticed after the fund was initiated. MAC became freer to respond to service requirements before funds were transferred. This was especially helpful with unforeseen, and therefore unforecasted, requirements. Thus, an expansion of capability could be programmed into the system (27:IV-2).

Planning, programming, and budgeting became even more necessary with the inception of ASIF because service requirements had to be submitted before the beginning of the fiscal year. Therefore, the services were forced to more accurately forecast their requirements at an earlier time than was required prior to MAC's funding by the industrial fund (6:39).

Major disadvantages of operating under the industrial fund also quickly surfaced. The main areas included the requirement for a year-end zero balance in the fund and the link betwen the FHPs and the tariff rate. As early as two years prior to ASIF implementation, these problems were recognized in a Price Waterhouse study which cautioned DoD ". . . not to make MATS dependent for its existence upon appropriations received by the three military services for the purchase of airlift" (1:2).

The study pointed out that MAC would be dependent upon the forecasted requirements of the individual services, over which it had no control. Also, since these projections were to be used to contract for commercial airlift and to set yearly tariff rates, it appeared that a situation might arise in the future where demand might be insufficient to maintain an acceptable state of readiness (1:2).

Unfortunately, since many of the services' forecasts were inaccurate due to mission changes throughout the year, tariffs in the period 1959-1975 changed approximately two to three times annually. In addition, reallocation of cargo from air to other modes in response to tariff increases magnified these trends. These reallocations caused fluctuations in revenues which, in turn, caused difficulty for MAC in meeting their year-end zero balance goals. In 1966, a Booz, Allen, and Hamilton study concluded that policies which require break-even at year-end should be modified to provide for controlled variances (2:1).

Because these reallocations made it even more difficult for MAC to maintain the desired break-even point, either the flying hour program or the tariff rate had to be adjusted. Since a decrease in frequency over some routes might have caused shrinkage in the MAC service to a trunkline operation and possibly degrade readiness posture, the FHPs went relatively unchanged. Thus, the tariff rates were increased (18: II-2).

Due to the Vietnam conflict in the late sixties and early seventies, much of the difficulty experienced with the ASIF tariff went relatively unnoticed. However, with a return to smaller peacetime cargo loads at the close of the war, the problem re-emerged with higher visibility.

As the war-to-peace transition occurred, airlift users became increasingly burdened with maintaining wartime capability with peacetime airlift demand. What had been a relatively stable structure during Vietnam began to inflate rapidly after 1972 and the scale-down of the war. However, the growth in the MAC tariff was caused by factors other than this geardown.

Figure 1 clearly shows the tremendous cost increases MAC was undergoing during this period. As the ASIF rates increased to reflect the combination of the above factors (Figure 2), the Army and Navy, who base their warehousing and pipeline decisions on the cost of transportation, began to take notice. By 1974, MAC was claiming that since the services were not generating airlift requirements equal to their forecasts (which served as a basis for the establishment of airlift tariff) mid-fiscal year tariff increases were necessary. As Table I shows, this mid-year increase did not prevent the 1974 ASIF from experiencing a $53.1 million deficit (27:V-1). MAC went on to cite the main reason for this loss, and the loss the next year, as the diversion of cargo to surface modes to save transportation costs. "Thus, MAC would size its tariff to generate break-even revenues assuming one level of requirements, but a reduced level was moved" (27:V-1).

Because of the perceived deficiences in this arrangement, various DoD elements had recommended numerous funding arrangements for the DoD airlift system in the years prior to 1974 (22:2). In 1974, a study by the Air Force entitled, "The Study of Funding Arrangement for the Department of Defense Airlift System," was commissioned by the Secretary of Defense (SECDEF). As a preface to this study, the SECDEF issued guidance ". . . on the consolidation of all airlift forces and a funding arrangement (to replace the existing

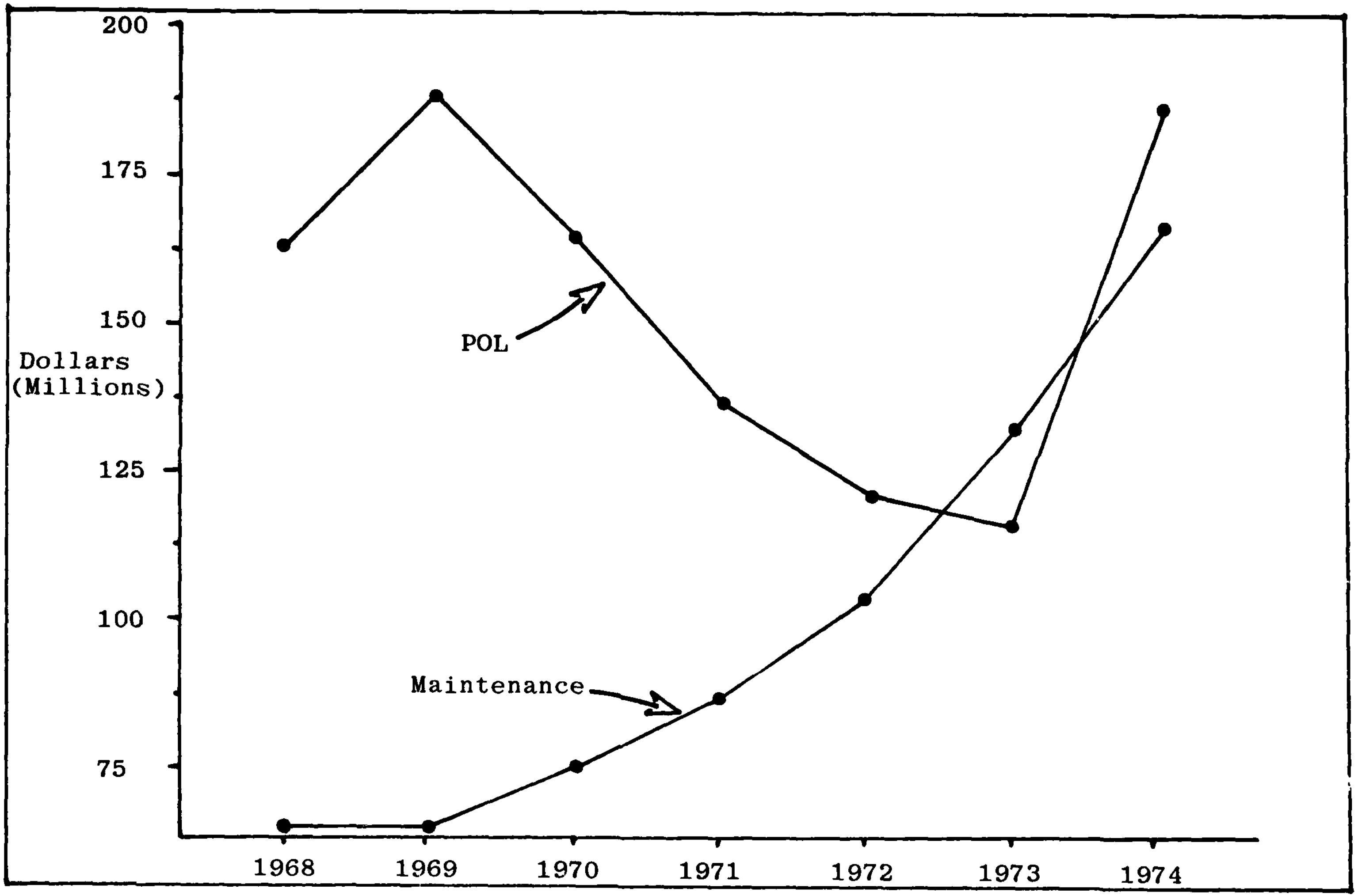


Figure 1. MAC POL and Maintenance Costs (27:V-4)

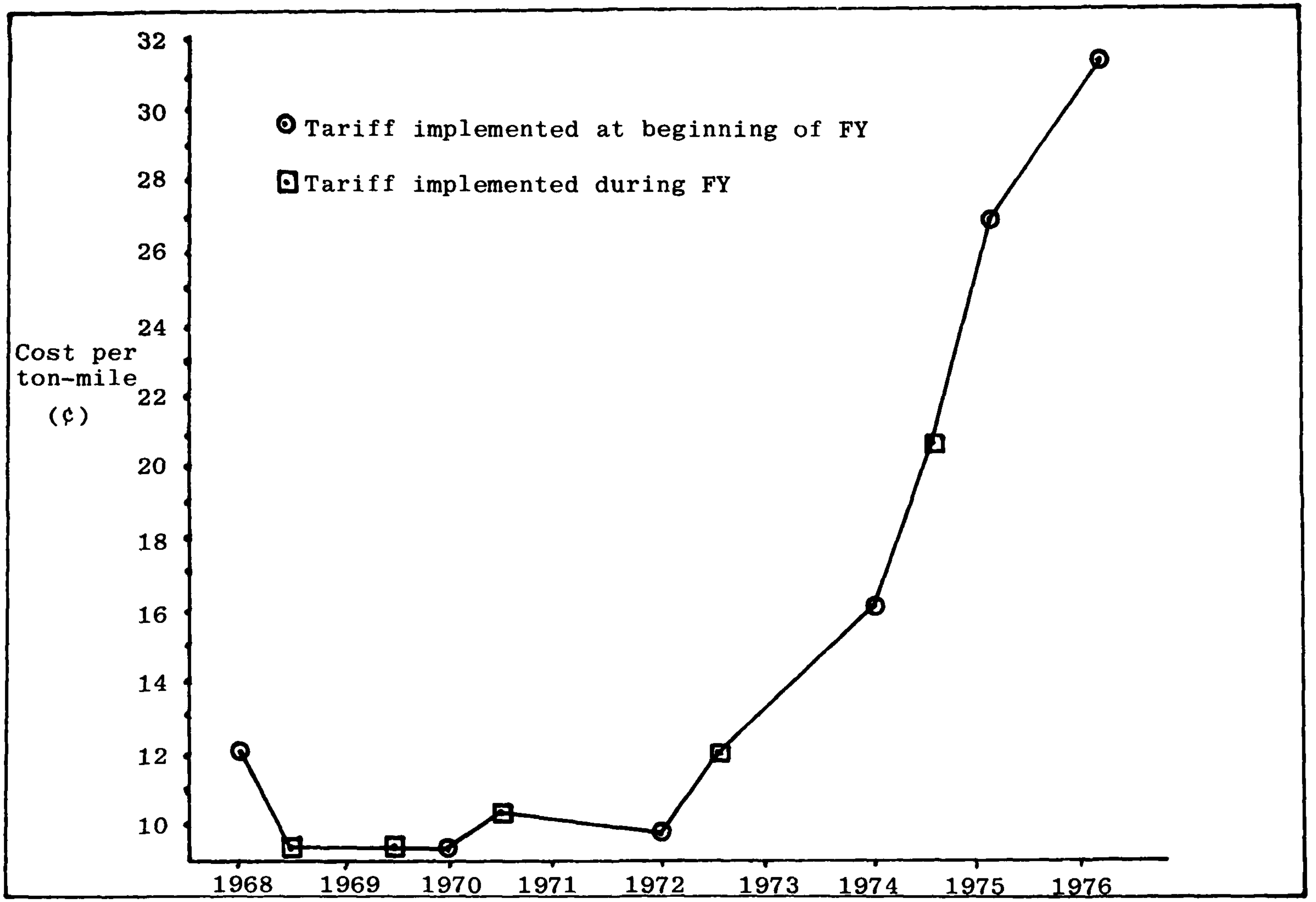


Figure 2. MAC Cargo Tariffs

TABLE I

Planned and Actual Cargo Movements by Service
vs. ASIF Profitability

Fiscal Year		WORKLOAD (Tons) Army	Navy	Air Force	Other	Total	ASIF Status (dollars, millions)
1970	Pres. Budget	314,740	142,691	259,212	5,190	721,833	
	Oper. Budget	295,602	134,300	249,376	5,003	684,781	-26.4
	Actual	257,747	105,726	273,790	21,380	658,643	
1971	Pres. Budget	278,375	121,609	238,903	4,797	643,684	
	Oper. Budget	257,505	82,482	220,803	22,932	583,722	+10.9
	Actual	158,918	93,918	244,071	29,050	526,757	
1972	Pres. Budget	241,631	70,630	165,547	10,882	488,740	
	Oper. Budget	171,855	71,694	171,104	23,254	437,907	-26.1
	Actual	144,347	92,482	258,216	21,953	516,998	
1973	Pres. Budget	153,409	86,289	225,105	23,895	488,698	
	Oper. Budget	127,883	80,526	189,503	7,225	404,727	+42.3
	Actual	114,881	93,335	236,896	6,030	451,142	
1974	Pres. Budget	120,468	82,500	166,897	5,978	375,843	
	Oper. Budget	102,9[illegible]	69,081	191,260	4,526	367,767	-53.1
	Actual	66,447	71,123	148,775	4,602	290,947	
1975	Pres. Budget	85,647	75,087	165,199	4,010	329,943	
	Oper. Budget	66,008	70,176	157,003	4,010	297,197	-31.6
	Actual	55,858	70,979	141,788	4,699	273,324	

(27:V-2)

ASIF) which excluded C-5 and C-141 operations from the industrial fund system" (4:1). Although the Air Force agreed with the consolidation, they concluded that some form of modified ASIF was needed in lieu of the SECDEF proposal because some form of financial accounting was needed to maintain transportation discipline as well as contingency responsiveness (4:1).

To study these issues, in late 1974 the Air Force established the Airlift Services Industrial Fund Sub-Committee composed of various elements of Air Staff and MAC. This group studied seven basic proposals which included the existing ASIF structure, five modified forms of the ASIF, and finally, one option to eliminate the ASIF entirely. The agreed-upon option required total airlift funding from both the users and Air Force accounts, depending on the level of user activity (4:2). This plan called for the provision of funds (direct appropriations) for minimum essential training when airlift capacity exceeded user requirements. The option would then be supplemented with an "incentive rate" on certain commodities to improve peacetime utilization, and hopefully to reverse the trend of the diversion of cargo from air to sea transportation. At completion, the results of this study were briefed to the Air Staff, which then voted to discontinue the ASIF. The following year, this vote was overturned by the Air Force Council, who decided to continue the ASIF. In response to the SECDEF commission, the Air

Force sub-committee proposed a new method of funding. The new method continued the ASIF concept and set up user "drawing rights" based on their forecasted requirements. It also allowed funding of the MAC FHPs with O&M dollars (5:1). However, these solutions to the ASIF problem were eventually disapproved by the SECDEF.

Although the use of O&M funding to support the FHPs was turned down, the concept of an incentive rate or "token tariff" was approved and implemented. This program, entitled the Transportation Priority 4 (TP-4) - CONUS bound household goods - program allowed the movement of cargo not normally air-eligible. This movement would occur at surface-comparable rates and would allow DoD to take advantage of excess airlift capacity, thus generating additional revenue. Concurrently, the services would be avoiding the substantial costs associated with the movement of this cargo by commercial ocean carriers. Thus, DoD would not be paying twice for the same movement, because capacity already being paid for in the ASIF would be utilized. No concern existed about the possibility of restructuring the services' existing pipeline and inventory policies, and therefore expanding wartime airlift requirements, due to the inclusion of only normally air ineligible cargo in the program.

The TP-4 program was not without its drawbacks. It was realized that full operating costs might not be covered by the token tariff and that the requirement for unused capacity funds might still exist. In addition, new costs would be incurred by MAC to allocate and monitor the flow of this new cargo into the system (27:V-5).

That same year, 1975, Mr. Eckhard Bennewitz of Operations Research, Inc. concluded a study for DoD entitled, "An Overview of Department of Defense Industrial Funds." This study addressed DoD industrial funds in general and concluded that:

> (1) Industrial funding of an activity does not in itself ensure efficient operation but management must see that the tools it offers are used effectively.
>
> (2) The prevailing attitude has been that despite its faults and limitations, the industrial fund concept provides greater latitude in financing and using resources to increase efficiency than appropriated funding.
>
> (3) Although improvements have been slow, continuing efforts have and are being made by those holding this attitude to minimize the negative impacts imposed by constraints and to capitalize on the advantages offered by this concept (8:1).

By 1976, the cost increases in maintenance and petroleums, oils, and lubricants (POL), in combination with increased organic capacity, had raised the ASIF tariff and therefore reduced MAC's workload.

> As workload decreased, MAC's airlift capability generated as a by-product of the FHPs continued to exceed service requirements. Where the unused capacity had previously been absorbed by the users in the form of increased tariffs, by 1976, they had increased to the point where inclusion in the tariff could no longer be justified. In FY 1977, these costs were separately identified and O&M Air Force funds were requested in the President's Budget (27:V-3).

This request for $27.7 million in direct appropriations for unfunded flying hours met with mixed reaction in Congress. Although both the House Armed Services Committee and the House Appropriations Committee approved the FHPs, the latter denied the unused capacity funds. This decision was based on the opinion that the flying hours supported by these funds should only be used when transporting cargo (27:IV-8).

Fiscal year 1977 also saw a move by DoD to stabilize the MAC rate structure. As previously addressed, prior to this time, the rates had changed constantly due to the cyclical nature of the ASIF and its reaction to any relevant economic changes.

Beginning in FY 1977, a Transportation Operating Agency (TOA) rate stabilization program was fully implemented. The principle features of the program included:

> (1) the tariffs of each TOA being established approximately 9-12 months prior to the start of the fiscal year,
>
> (2) once established, the tariffs would not be adjusted until completion of the fiscal year,
>
> (3) the tariffs were to be established to permit each TOA to "trend" toward a no-profit/no-loss financial condition (27:III-6).

The main thrust of this program was three-fold, with the goals inter-related. The establishment of tariffs in the 9-12 month window was designed to tie service requirements to the Planning, Programming, and Budgeting System. The previous method, in which rates had been set by OASD(C) approximately one month prior to the fiscal year, had caused the airlift user problems in that service budgeting was based on rates from the current fiscal year due to the lateness of the upcoming year tariff publication. If the MAC tariff that was applied for the forthcoming year was higher than the rate applied by the services in developing their budgets, reallocations once again occurred. This provision of the plan was aimed at stopping this trend.

Closely tied to this concept was the elimination of mid-year tariff changes, which had only served to increase the severity of the problem. The third concept of the program, the permittance of each TOA to "trend" towards a no-profit/no-loss financial condition, was geared to eliminate the emphasis on breaking even in the short term, and stress balancing out in the long term (27:III-6). This feature of the program was the overall goal of the revision, and was intended to eliminate large tariff increases and/or decreases in subsequent years and thus stabilize airlift demand.

An important contributor to the changes implemented in FY 1977, General Howell M. Estes, Jr., retired, published a 1976 study entitled, "The National Strategic Airlift Dilemma: An Approach to Solution." In this two-volume study, General Estes pointed to the ASIF as a valuable management tool which, if scrapped, could only be replaced by a new method incorporating many of the ASIF's basic procedures. He stated that

> " . . . the causes of underutilization lie not in faulty management of transportation, but rather in an inadequate assessment and analysis of the DoD logistics system and of the optimal interactions between that system and the DoD transportation resources, particularly air transportation" (18:32).

Further, a Senate Appropriations Committee Report (97-446) identified the causes of MAC underutilization "as the lack of adequate centralized management of DoD transportation resources" (18:20) and set the stage for the controversy surrounding the ASIF today.

As for solutions to the problem, Estes was in agreement with the stabilization program implemented in FY 1977. He did, however, once again call for the funding of unproductive flying hours (the difference between hours flown for customers and those which must be flown to maintain airlift system readiness) with AF O&M funds.

His reasoning for this proposal was the need to keep the tariff competitive, where competitive was intended to ". . . mean a tariff which would bear a reasonable relationship to standard commercial scheduled air cargo tariffs and would be closer to overocean container shipping rates" (9:5). Estes felt that the high MAC tariff rates were disincentives to increased utilization of organic airlift for logistics requirements.

Although Estes' recommendation for O&M funding of unused capacity was not adopted, it did once again spark re-evaluation of the ASIF structure. In 1977, the Air Force Panel (Air Force Board structure) was tasked to "review the advantages and disadvantages of the ASIF and its contributions to airlift readiness for the wartime mission as well as to peacetime logistics efficiency" (3:1).

The conclusion of this study was to continue the ASIF. As had been the case with previous studies, the panel recommended certain improvements. These included:

(1) Update ASIF charter to show that the ASIF focuses on the airlift by-product of readiness training.

(2) Develop an information/education program to improve understanding of the ASIF.

(3) Review transportation and supply policies.

(4) Require transportation impact statements in all program decisions (3:1).

<u>MAC and ASIF Policy Today</u>

Through the years, the ASIF tariff rate and the costs included in that tariff have received a great deal of consideration. The cost categories that have, since the inception of the ASIF, been funded by Air Force operational and maintenance dollars include the acquisition costs of aircraft and real property facilities, military personnel costs, and common base services. Since 1976, the cost of flying hours, to include local exercise and many air-refueling practice missions, which are non-productive in terms of cargo capacity, have also been Air Force O&M funded.

In 1972, an Air Force Institute of Technology graduate thesis by Freer and Ohl evaluated each ASIF cost category to determine whether or not it was a legitimate strategic readiness training expense. They suggested that those expenses which were strictly tied to readiness should be funded with Air Force O&M dollars and not levied on the services as a cost of airlift. Through development of a set of decision rules, they succeeded in estimating an expense reduction of 48.4 percent of the original $666,769,000 estimated FY 1973 ASIF recoupable expenses (20:44). Similar efforts in this area have resulted in the same general findings.

It is evident that there exists a notion in the military community today that airlift prices are not optimal to the user if the goal is to ration all of the available supply of MAC capacity to those who value it most highly. A 1983 MAC study initiated to examine the continued problem of high tariff rates focused on a two-fold problem, one near-term and the other long-term:

> (1) High tariff rates are driving DoD cargo out of the established channel routes. Reduced budgets of the military services have caused them to look for modes of transportation which are less costly than MAC channel service. This cause and effect situation has the potential of degrading the readiness of the DoD airlift system.
>
> (2) MAC capacity in the future years will signicantly increase with the re-winging of the C-5 aircraft and the purchase of new aircraft to meet the wartime airlift needs. At the same time, a level of airlift must be purchased from civil

> airlines to maintain their commitment to the CRAF program, which is a vital part of MAC's wartime readiness capability (29:I-3).

The study directed by OASD for Manpower, Reserve Affairs and Logistics (MEA and L),

> . . . was intended to take a new look at the approach used in procuring and reimbursing the costs of MAC passenger and cargo airlift with a view toward eliminating the apparent inconsistencies in the current tariff rate structure and insure optimimum utilization and readiness of MAC capability in the future (29:I-3).

A driving force in the commissioning of this study was the need to measure the effect of commercial airline deregulation on MAC's cargo movement. It was found that although deregulation ". . . had in recent years created numerous situations when commercial air transportation was available to DoD users at lower prices than ASIF tariff rate offers" (29:I-2), the ability to take advantage of the lower rates was restricted to a limited number of routes, which often contained special conditions or restrictions (29:I-2). An immediate complication to the findings was the OSD imposition of a tariff rate for the ASIF which was designated to produce a profit in the fund to cover losses experienced by other industrial funds. This added burden to the user put MAC at an increased disadvantage when compared to the deregulated commercial carriers.

In an attempt to gauge user perspective regarding the airlift system, questionnaires were sent to all of the military services. Among the questions asked were:

(1) How much of your air eligible cargo is currently being shipped by surface?

(2) What sort of price structure and/or allocation method is required to attract some of that cargo to air (29:I-6)?

In total, the services identified approximately 44,000 tons of air eligible cargo (TP-1 and TP-2) that, due to budget constaints and higher than allowable tariffs, was shipped by the surface mode annually (29:I-7).

In response to the second question, suggestions were made that time sensitive Exchange and Commissary goods could be future candidates for airlift, given a rate structure that was comparable to sealift. In both cases, decreased pipeline and inventory costs that could be realized through use of a premium mode of transportation were acknowledged. However, in the case of the TP 1 and 2 cargo, it was felt that many items in these categories already had distribution systems in place that were predicated on airlift. By shifting to sealift to minimize transport costs, many shippers actually suboptimized readiness by failing to restructure their inventory policies to reflect the slower transit times. Hence, inventory pipelines were not long kept at optimal levels.

An underlying theme in all survey answers was the need to make MAC tariff rates more competitive with commercial alternatives. Examples such as the cube billing rule (a rule in which MAC uses a 12.5 pound to the cubic foot standard for billing as opposed to the commercial 10.4 pound standard), were cited as uncompetitive practices by MAC/ASIF. In addition, those surveyed identified the need for MAC to fund unsubscribed FHP hours with O&M dollars, reiterating the need to bring rates more in line with the commercial sector (29: I-7).

The Military Airlift Command policy regarding the ASIF can be found in the same 1983 study (29:ES-1). The policy states that the users are in the best position to justify the use of air transportation depending on their pipeline and inventory needs. Therefore, the ASIF tariff rate is an economic measure of the "value" of this premium mode of transportation to the logistics management decision process (29:ES-1).

This study, in replying to the recommendations of the various studies done prior to 1983, stated that since the original ASIF procedures were developed, the numerous studies that have attempted to define which costs were exclusively readiness costs and thus should be excluded from the ASIF tariff base, could technically have said that <u>all</u> costs were readiness costs because the entire MAC program revolves around the mimimum training necessary to maintain aircrew proficiency and terminal support capability to ensure a wartime readiness posture (29:V-2).

The report went on to state:

> If all of these costs were excluded from the ASIF and financed by the Air Force, there would be no cost base from which to develop a tariff which would serve effectively as a system to allocate the by-product airlift capacity of the peacetime training program among the DoD agencies (29:V-5).

As currently constructed,

> The expense base for computing the tariff includes the cost of services procured from commercial airlines, civilian pay, fuel, temporary duty for aircrews, maintenance of aircraft, operation of cargo and passenger terminals, and a portion of the expenses of MAC Headquarters engaged in the administration of airlift operations. Exclusions include military pay, major procurement items or their depreciation, and base operating and support costs (38:6).

Table 4 shows the Fiscal Year Budgets for 1983 and 1984. One quickly can identify the high cost items that have the greatest influence on the tariff rate.

TABLE II

MAC ASIF Expense Budget
(dollars in millions)

Item	FY 1983	FY 1984
Aircraft Direct Operating Cost		
Aviation fuel	1,029.0	889.4
Depot maintenance	335.7	348.6
Civilian pay	48.8	49.8
Travel and per diem	42.0	43.0
Supplies and equipment	162.6	182.2
Miscellaneous contracts	45.8	48.8
Subtotals	1,663.9	1,561.8
Commercial Augmentation	474.9	530.7
Terminal Services	80.1	92.1
Command and Control/Cmd Admin	32.2	43.3
Total ASIF Expense Budget	2,251.1	2,219.0

(29:V-2)

These cost categories which are basically the same as included in the original makeup of the ASIF, were recommended by the aforementioned Price Waterhouse study in 1956. Although that study recommended against the use of an ASIF, it did recognize that, due to the overriding requirement to maintain readiness capability, certain economies of scale, present in the commercial world, would not be present in the DoD. The study, therefore, determined that certain cost elements should (and would) have to be excluded from the cost base to keep rates from being prohibitive (29:V-5).

Although the exclusion of these cost elements from the tariff cost base in past years appeared adequate to insure a reasonable rate structure, recent strategic airlift policy has forced MAC into re-evaluating what should and should not be included in that base.

The previously stated revisions of strategic policy have caused a gap between the total requirements on MAC and the command's total war movement capability, with a large portion of this gap being caused by the addition of heavier and bulkier major combat equipment to the conventional weapon inventory. The national defense policy of flexible response increases this problem by requiring airlift to be prepared to deliver large numbers of troops to locations anywhere in the world on short notice (26:11).

In 1980, recognizing the cargo airlift shortfall had reached alarming proportions, Under Secretary of Defense Chaynes issued a memorandum stating that these shortfalls were as high as 150 C-5A equivalents in some scenarios (12:30). Recognition of this shortfall caused interim actions, such as the now completed C-141 stretch and the on-going C-5A wing modification, and other long-term actions, such as the formation of a commission to review our national airlift posture, to be taken (15:12).

The 1981 Congressionally Mandated Mobility Study findings resulted in a move toward enhanced airlift capability to support the policy of peace through strength. This effort caused DoD to adopt a three-pronged airlift enhancement program (36:175).

The first component of the program addressed existing short-term shortfalls in our ability to move outsize cargo, other cargo, as well as increasing aerial refueling capability. This was accomplished through the immediate procurement of 50 C-5Bs and 44 KC-10 aircraft.

The second component was aimed at upgrading CRAF capability by modifying commercial wide body passenger aircraft to handle military cargo (37:97). The government plans to incentivize carriers with up-front payments for the conversion and operating subsidies through the life of the plane. This method is thought to be a relatively cheap method of enormously increasing MAC capacity since more than 25 percent of strategic lift capability could come from civil 747s during a contingency (32:11).

The first two components are relatively short-term efforts. As a long-term solution to the airlift shortfall, and to eventually replace the aging C-130 and C-141s, the Air Force is pressing Congress for funds to develop the C-17, a new long-range cargo aircraft with the approximate cargo capacity of the C-5 and the tactical capabilities of the C-130.

This total enhancement program then, if funded, could ". . . increase the nation's strategic airlift capability by 75 percent in the next ten years and better than double the current capability by the late 1990s" (37:92).

These projected increases raise important questions about MAC funding. Under the ASIF, tariff rates charged to airlift users are derived from the costs of maintaining MAC personnel proficiency and system readiness. Because channel cargo carrying capacity is a by-product of the constant training required to meet the MAC mission, the tariff is designed to cover the costs of those projected training hours plus other related cargo movement and flying hour program costs.

In order to address the pricing problems anticipated with the introduction of this new capability, MAC has favored moving toward a tariff rate based on an economic value principle (29:V-3). This pricing policy proposes the elimination of tariffs based on fully allocated system costs, and advocates a tariff rate competitive with commercial airlines.

This leads to a more efficient operation as airlift customers cease seeking alternate modes of transportation, thus attracting cargo to fill unsubscribed capacity.

Several modifications to current ASIF practices were suggested in the 1983 MAC study, all of which were intended to increase the competitive stance of MAC in relation to commercial air and water carriers. These modifications included:

(1) Use of an incentive rate to attract selected, normally air-ineligible cargo.

(2) Tariff rates designed to attract air-eligible cargo currently moving by surface mode.

(3) Fencing air-transportation dollars. (Reprogramming of funds not allowed.)

(4) Increased use of O&M funding to allow tariffs to move toward an economic value (29:VI-1 - VI-5).

To a large degree, the reasoning for these suggestions was driven by the scheduled increase in both organic and CRAF capacity as a result of the KC-10 and C-5B buys, and the C-5A wing modification. In addition, it is currently MAC peacetime policy to increase the commercial contract movement of DoD cargo to ensure CRAF readiness in time of conflict (29: IV-14).

As projected by MAC, the unsubscribed capacity resulting from these programs is as shown in Table III.

TABLE III

Unsubscribed Outbound Capacity
(MTM)

FY	CRAF	KC-10	C-5B	Total
84	57	10	--	67
85	103	15	--	118
86	124	19	13	156
87	124	23	92	239
88	124	38	171	333
89	124	38	247	409

(29:IV-4)

In conjunction with the projected increase in capacity resulting from these programs is the expected increase in user justified airlift requirements, estimated at two percent annually. This minimal annual increase would mean that, lacking any changes in policy, 37 percent of the 1989 MAC cargo capacity would go unsubscribed (29:IV-14). Lacking a method of attracting new cargo or distributing costs would result in a prohibitively high tariff and a worsening of the MAC deficit position.

As a partial solution to the situation, MAC advocates the total O&M funding of the C-5B program. In addition, the command suggests that as the C-5A wing modification program is completed, the O&M dollars budgeted against that portion of the aircraft's unusable capacity be redesignated to cover future increases in CRAF utilization. Table IV portrays MAC's estimates of what this funding would encompass.

TABLE IV

Air Force Readiness Funding-Unsubscribed Capacity
(FY 1984 Constant Dollars in Millions)

Readiness Program	FY85	FY86	FY87	FY88	FY89
C-5A ACL Restrictions	68.8	37.1	18.9	--	--
C-5B DOC	--	10.6	39.8	90.0	146.1
CRAF Participation	49.8	75.4	94.0	94.0	94.0
Totals	118.6	123.1	152.7	181.0	240.0

(29:V-4)

With this program in place, MAC feels that they will be able to stabilize the rate structure, and then, utilizing incentive rates, attract new cargo to the system. As a prerequisite to competitive rate setting, MAC argues that since an economic value tariff would, in effect, force Air Force to pay in budget dollars for unsubscribed capacity, the fencing of air transportation dollars to air transportation services should be incorporated into the services' budgets (29:IV-17).

In addition, based on services' recommendations, MAC, in April 1984, instituted a test program on the Pacific channels which uses incentive tariffs to attract outbound household goods, commissary stock, exchange items and other morale-building goods.

Finally, MAC is recommending a tariff system that would make obsolete the 12.5 pound cube rule. It would be replaced with a weight break tariff structure intended to give progressively lower rates to shippers as shipment weight increases. "This will encourage large shippers to use MAC channel service, thus maintaining the infrastructure of the channel system necessary for wartime operations . . . " (29: VI-3). Additionally, recommendations are being made to change the 12.5 pound/cube rule to 10.0 to place MAC in a competitive position relative to the commercially accepted 10.4 factor.

Thus, it appears that MAC, in anticipation of future increases in the ASIF expense budget, due to greater organic capacity, has proposed two logical policies intended to alleviate the problem. However, an interesting question remains. If MAC does succeed in offsetting the cost of the additional capacity generated by new airlifters, and thus succeeds in providing the services with a competitive tariff, at what level should that tariff be set to insure optimal year-end results? The answer to this question would, due to the cyclical nature of the tariff rate computation, partially determine the level of O&M funding required for the following year. In the absence of additional O&M funding, the relationship between the tariff rate and revenues received will determine whether ever-increasing ASIF deficits are encountered.

With the stage set, we now turn to the central question pursued in our study: What will be the impact of MAC's pricing policies on demand for airlift and thus on the total revenue generated in the ASIF?

III. Demand Theory and Model Formulation

Demand Theory

This chapter will familiarize the reader with the theory involved in model formulation and then will cover the steps utilized in performing the study of elasticity. It will serve as a refresher for those concepts most central to the issues addressed in the thesis, and then explain how they were applied to this study.

What is a Demand Curve?

> Demand is a relation showing the various amounts of a commodity that buyers would be willing and able to purchase at possible alternative prices during a given period of time, all other things remaining the same (33:44).

Demand is usually related as a function. Watson and Holman (39:13) define the demand function as the relationship between differing amounts of commodity and the price, buyers' income, buyers' tastes, and/or the price of like commodities which determine the amount of that commodity a consumer will purchase. Key to this relationship is the fact that although price and demand may vary, all other variables are assumed to be constant during a particular time interval.

Consider the demand schedule shown in Table V. Figure 3, which depicts graphically the tabular data in Table V, allows the viewing of the demand function so that basic relationships can be seen.

TABLE V

Demand Schedule

	Price per Product	Quantity Demanded per Time Interval
A	$5	5
B	4	10
C	3	20
D	2	35
E	1	60

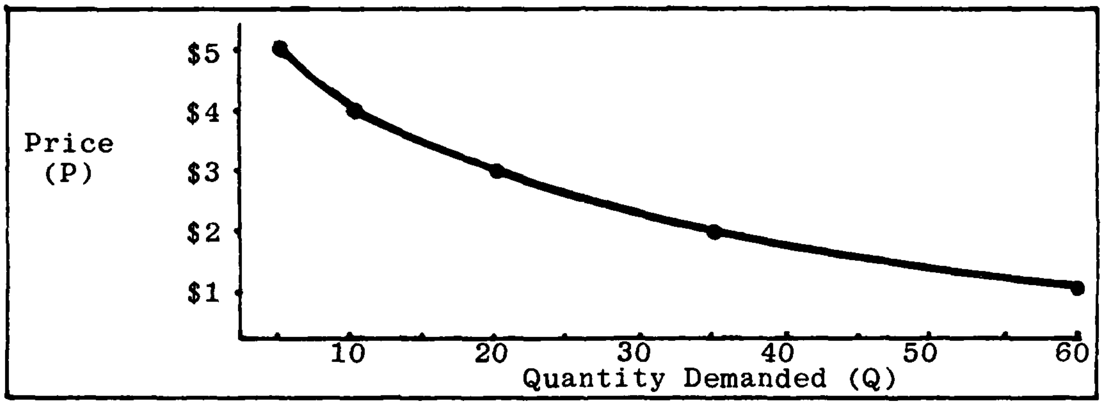


Figure 3. Demand Function Relationships (33:45)

It should be noted that the demand curve slopes downward from left to right, reflecting the fact that the quantity demanded of a product varies inversely with the price, all other factors held constant. This is commonly called the "Law of Demand."

Although there are a multitude of reasons which explain the law of demand, three of the most important are:

> (1) If the price of a good decreases, you can afford to buy more of it if your income, tastes, and the prices of other goods remain the same.
>
> (2) When the price of a product is reduced, you may buy more of it because it becomes a better bargain than other goods -- assuming as before that your income, tastes, and the prices of other goods remain constant.
>
> (3) The downward sloping demand curve tells you that you would be willing to pay a relatively high price for a small amount of something, but the more you have of it the less you would care to pay for one more unit (33:46).

Determining the Demand Curve. When attempting to estimate a demand curve for a commodity, the researcher must be cognizant of two related but distinct variations which may be present in the marketplace. One is the change in demand and the other is called the change in the quantity demanded.

The change in quantity demanded is a movement along the original demand curve caused only by raising or lowering the price of a product. In contrast to a change in the quantity demanded, a change in demand represents a shift in the entire demand curve such that at the same price a greater or lesser quantity would be demanded. This shift is due to a change in the variables we had previously viewed as constant (a change in the market). For example, if a product which was a close substitute had a significant price increase, consumers would move away from that product and would purchase more of the product which is now relatively less expensive. At any given price a larger quantity would be demanded. This would result in a shifting of the curve to a position farther from the origin, as shown in Figure 4.

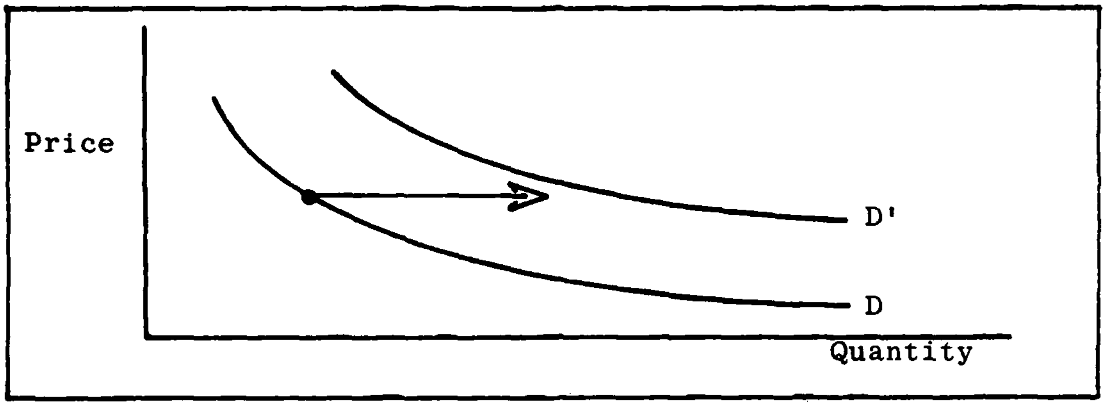


Figure 4. A Change in the Demand Schedule (9:35)

Other factors which may shift the demand curve include changes income, tastes and preferences, the number of purchasers in the market, and expectations of future prices and incomes. This list illustrates the factors which must be controlled for when trying to examine how the change in any one variable affects the change in demand.

<u>Elasticity of Demand and Its Relationship to Total Revenue</u>. The concept of price elasticity of demand is very important to this research because it describes the effect that a change in price will have on total revenue. Elasticity is defined as:

$$E = \frac{\%\ \text{change in Q}}{\%\ \text{change in P}} \qquad (1)$$

where:

Q is the quantity demanded
P is the price
E is the elasticity of demand

Two things happen when we increase price. First, we will receive more money for each unit we sell, and second, we will sell fewer units. If the fact that we are getting more money for thje units we sell more than makes up for the fact that we are selling fewer units, then total revenue will increase. In other words, if we raise price and the percent of change (increase) in price is greater than the percent change (decrease) in quantity, total revenue will increase. If this is the case, then the value of E will be less than the absolute value of ($|1|$). We call the above relationship the price elasticity of demand.

If $E < |1|$, it is inelastic,
if $E = |1|$, it is unitary elasticity,
if $E > |1|$, it is elastic.

The relationship of price increases to total revenue and elasticity is as follows:

P	TR	E
↑	↑	inelastic
↑	same	unitary elastic
↑	↓	elastic

When price decreases, the fact that we increase sales may more than offset the decreased revenue per unit. If we want to see total revenue increase with a decrease in price, the the percentage change (Δ) in quantity must be greater than the percent decrease in price. These relationships are shown below:

<u>P</u>	<u>TR</u>	<u>E</u>
$\downarrow$	$\downarrow$	inelastic
$\downarrow$	same	unitary elastic
$\downarrow$	$\uparrow$	elastic

An estimate of price elasticity provides a basis for predicting the effect of a change in price on total revenue.

<u>Empirical Estimation of Demand Curves</u>. A problem common to any statistical analysis of supply and demand is that of identification.

> The basic question is whether it is possible to deduce statistically the theoretical demand or supply functions when we know only the observations corresponding to the intersections of unknown demand and supply curves at different points in time or across different classes of consumers (10: 33).

This statement points out that since each price-quantity pair is a point, not only on a demand curve but on a supply curve, difficulty exists in identifying either or both of those curves from a scattered number of data points. Prices are determined by the interactions of two distinct groups: those supplying the good and those demanding the good. Typically, it is assumed that those supplying the good will supply more at a higher price (supply curves slope up) while those demanding the good will demand more at a lower price (demand curves slope down).

Due to the nature of the supply curve in our model, there is no problem in identifying the demand curve. As stated by Douglas R. Bohi in Analyzing Demand Behavior,

> If it were known that demand relationships between price and quantity were stable and the supply relationship shifted from one unit of observation to another, the sample of data points would lie along the theoretical demand relation and could be estimated with ease (10:33).

Since the supply curve of MAC ton-miles in this study shifts in a quantifiable manner from one unit of observation to another (ton-miles available per fiscal year) we can easily trace out a supply curve for each year. The situation we are faced with can be viewed as a series of horizontal supply curves. Since the price variable (tariff rate) is fixed during each year, the problem of tracing out the demand curves becomes simply a matter of plotting the various data pairs (price and quantity). This means that at any given tariff rate for a year, MAC will provide air transport at that tariff rate, whatever the particular quantity demanded. This situation is illustrated in Figure 5.

It is for these reasons that relatively minor mention will be made of the supply curve during the remainder of this research.

Regression Equation. As previously discussed, any attempt to estimate a demand curve has several concerns. An important consideration is whether demand changes from one period to the next indicate a change in quantity demanded or

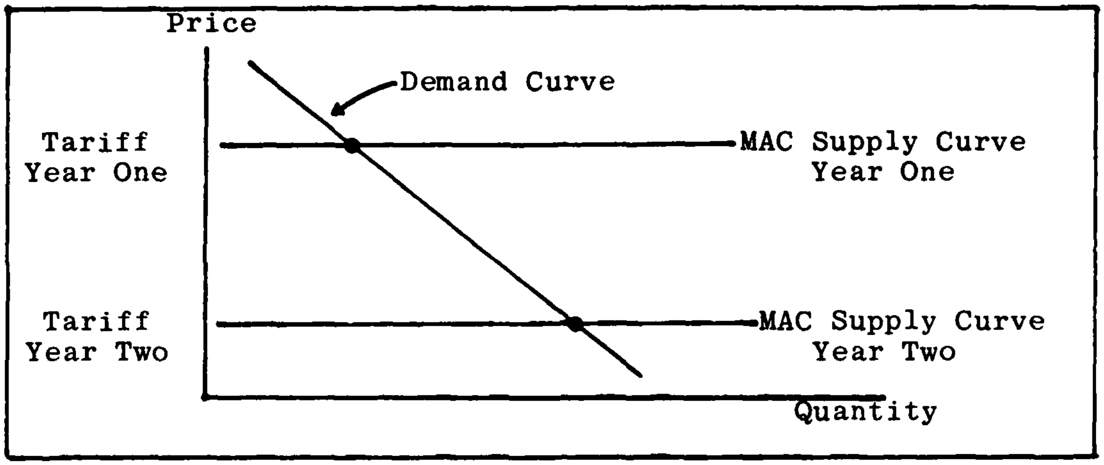


Figure 5. Formulation of Demand Curve Given Constant Supply

a change in demand. Any attempt to derive a demand curve must consider the price of substitute goods, income and taste, as well as price and quantity. This research used a multiple regression model to estimate the demand for MAC cargo transport. The multiple regression model serves the important purpose of eliminating the problem of a shifting demand curve by implicitly controlling for factors which might shift the curve.

Statistical Considerations. In constructing the model, we realized that its statistical form could take on any one of a large number of possibilities. Although the functional form could have been addressed empirically through use of a computer search program, we chose to use an approach common to economic research -- that of the linear or the log/log form. Also, as is nearly always the case in elasticity of demand studies, it was necessary to work with aggregated data.

The data have been aggregated from command level to service level, and then combined for use in one equation. For each year included in the model, there is one observation for Air Force, one for Army, one for Navy/Marines, and one for a category named "other" which includes such organizations as the Defense Logistics Agency and the Office of the Secretary of Defense. An implication of this combined data is that the estimated relationship may be sensitive to the composition of the total. This could happen, for instance, if the price elasticity of demand for MAC air shipments differs between the Navy and the Air Force.

Model for MAC Tariff Determination Process

When the ASIF tariff rate is being computed, numerous interrelated decisions are made at various levels in the Department of Defense (DoD) which influence the effectiveness of that designated tariff rate in financing MAC's flying hour programs (FHPs). These decisions are closely linked to the government budgeting cycle which is the basis for approval of both the tariff rate and the DoD operating budget.

Each DoD service receives long-range inputs from their major commands that describe mission requirements for budgetary forecasting. Within these submissions are a subdivision delineating the commands' forecasted airlift requirements in tons. These requirements are estimated from historical data of airlifted cargo and prospective changes in movement requirements. These changes could be due to changes in force structure, weapons deployment, support requirements, the number of personnel stationed overseas, plus various other factors (35).

In consolidating their major commands' projections, the services consider factors that affect their respective services. The major factors, at this level, are the projected tariff rate for the year in question and the projected level of O&M funding for the same period. Tariff rate projections are based upon the present tariff plus a specified tariff inflation factor which is published by the Office of Management and Budget (OMB). If the tariff is expected to be higher, with no forecasted increase in O&M funding for that period of time, then the requested funds for airlift will have to be higher, or the service may shift requested funds to another form of transport -- sealift.

The forecasted ton-miles are computed through a decision process which can be quantitatively modelled. Thus, the relationship between the decision variables which influence the services' airlift forecasts can be hypothesized in an equation format where

$$\sum_{ij} \widehat{ETM} = \widehat{PAIR}_2 , \widehat{PSEA}_2 , \widehat{MAN}_2 , \widehat{OPRBUDG}_2 \qquad (2)$$

where

i	=	command aggregation
j	=	service aggregates
ETM	=	estimated million ton-miles
PAIR	=	price of airlift
PSEA	=	price of sealift
MAN	=	overseas manning numbers
OPRBUDG	=	Congressionally approved operating budget

This equation represents a general form of the decision criterion which goes into estimating future service movement requirements. The subscript number indicates the year dealt with when making the decision and the "$\wedge$", or hat, mark over the different variables demonstrates that they are also estimated factors. Each service's estimated ton-mile and budget requirement forecast is forwarded to OSD. However, only the ton-mile forecast is forwarded to HQ MAC.

Forecasts submitted to HQ MAC by the services arrive by 1 November (23 months prior to the beginning of the operating year) and are used to set a projected tariff rate which corresponds to that same year (13). Flying hour program goals are used to estimate the ASIF expenses for the year in question. (See Table IV in Chapter II for the ASIF expense categories). The year end balance from the year before, MAC's FHP operating expenses, and the projected ton-miles are all critical to the determination of a tariff rate. These factors, as seen in the following equation, all help in identifying what the price of airlift should be:

$$PAIR_2 = \frac{\widehat{ASIF}_2 - [\,(ATM_1 \;X\; PAIR_1) - EXP_1\,]}{\widehat{ETM}_2} \qquad (3)$$

where

PAIR	=	price airlift
ASIF	=	estimated ASIF expenses for next year
ATM	=	actual ton-miles shipped the present year
EXP	=	ASIF operating expenses the present year
ETM	=	estimated ton-miles for the next year (6)

Actual ton-miles (ATMs) times the tariff rate (PAIR) equals the total revenue of the present fiscal year. Total expenses for this year are then subtracted from the revenue figure. If expenses exceed revenue, then this number is added to the projected ASIF expenses for the next year. If total revenue exceeds expenses for the present year, then the ASIF is running at a surplus and the extra dollars can be subtracted from the projected next year's ASIF expenses. Eq (2) demonstrates the method of estimting the ton-miles to be shipped in the next year and it is these estimated ton-mile figures that are divided into the forecasted MAC operating expenses for the next year. The quotient of the division is the tariff rate that MAC intends to charge and it demonstrates how a zero balance can be achieved at the end of the year.

This tariff rate is then forwarded to OSD where it is compared with each of the service airlift budget forecasts. If the tariff rate is higher (or lower) than the inflated projected tariff, the services' dollar figures may be adjusted to be more in line with the cost of the ton-mile projections submitted. All service requirements (including airlift) are consolidated at this level and, with the tariff rate, are forwarded to the Office of Management and Budget (OMB).

The OMB reviews the DoD budget submission with those of all the other federal agencies and works in concert with the Defense Resources Board and the SECDEF to consolidate the DoD budget submission with the others in a manner that will hopefully receive Congressional approval while maintaining defense goals. From these discussions the Program Budget Decisions are finalized. These decisions are then reviewed by the President who makes any changes he believes will be consistent with his stated policies. Thus they become the President's, or the Unified Federal, Budget which is sent to Congress for approval in the January/February time frame.

Congress conducts hearings with DoD personnel to collect justification for budget submissions throughout the remainder of the fiscal year and adopts an operating budget level for each budget activity by the end of September. This authorized operating budget is sent to OMB which apportions the funds to each DoD service which, in turn, allocates funds to each major command. (See Figure 6 for entire process.) At the same time, an updated approved tariff rate is released by MAC in preparation for the coming fiscal year. In response to the tariff rate, the actual tons shipped by air will be a

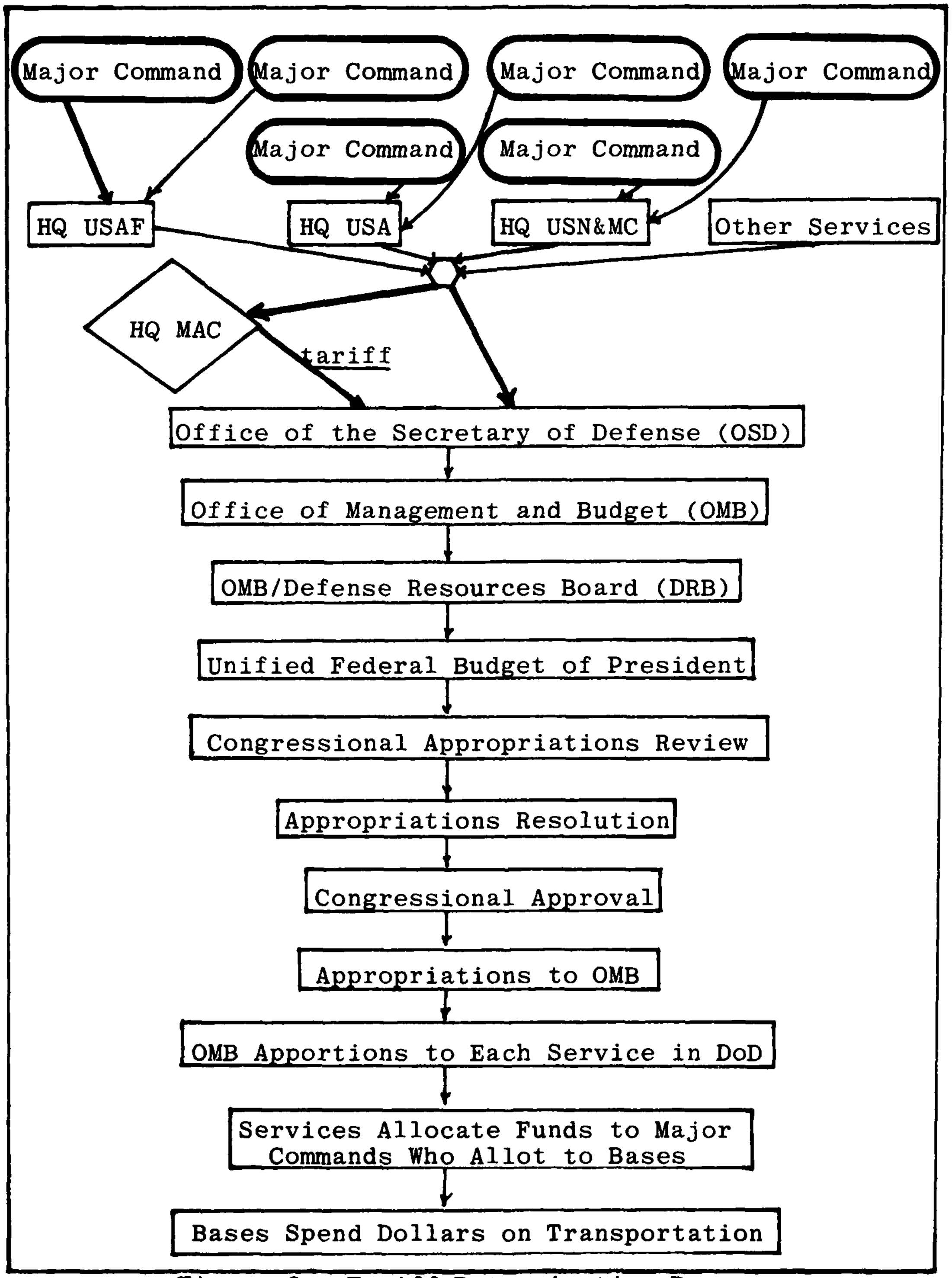


Figure 6. Tariff Determination Process

function of the price of airlift, the price of sealift, overseas manning numbers, the approved operating budget, and other factors. As previously described, these actual ton-miles (ATMs) shipped will, in turn, affect the calculation of the price of air shipments for the next year.

The relationship of the MAC tariff to actual ton-miles shipped becomes very important when it is realized that MAC is in the process of purchasing 50 C-5Bs and 44 KC-10s which will start coming on-line in 1986, and the overall operating expenses per year will begin to steadily increase until all the new aircraft have been brought into the inventory. The additional planned purchase of C-17 aircraft to start entering the inventory at the end of the decade will further exacerbate the operating expense problem.

As operating capacity and expenses begin to rise, MAC can either lower or raise the tariff. If it lowers the tariff (through incentive rates or whatever means), capacity utilization can be expected to increase. However, MAC revenues will increase with a lower tariff only if demand is elastic. If MAC raises the tariff and demand is inelastic, total revenue will go up and the new aircraft expenses will be offset. As long as demand is inelastic, there is some range of tariff increase which would offset the increased cost and leave the ASIF with a desired zero balance. (Realistically, it may take a few iterations of tariff changes to discover the tariff which achieves this.) This will allow

MAC the decision of whether to decrease or leave the tariff rate the same for the following year.

On the other hand, if demand is elastic and if the present method of determining the tariff is used, then ever-increasing annual tariffs will result as the ASIF deficit grows from year to year.

The data that was utilized in the regression equation will be presented and analyzed in the next chapter (Chapter IV). Chapter V will present the conclusions drawn from the regression results and some recommendations for further studies in the area.

IV. Data Presentation

Since 1977 and the inception of the MAC rate stabilization program, much effort has been expended in attempts to develop pricing policies which would encourage the use of MAC airlift services. However, to this date, no research has analyzed the impact of alternative MAC pricing strategies on MAC revenues. It is for this reason that we present a regression model which quantifies the reaction of the military services to changes in the MAC tariff rate. The model results have been used to project the effects of possible future rate changes on demand and to thus discover the resultant changes in total revenue. It is hoped that this model will be an aid to decision makers attempting to evaluate the likely consequences of contemplated tariff rates and to discover options available to them when deciding what to do to increase or decrease total revenue.

Limitations

In developing the price elasticity of demand model for MAC airlift, several limitations were encountered. The main two were:

(1) The limited number of usable years of data.

(2) The scarcity of readily available, compiled data.†

Each of these will be discussed briefly in turn.

†In order to facilitate future research, the entire data set is replicated in Appendix A.

Due to United States involvement in the Vietnam conflict, demand levels for MAC airlift in the years just prior to 1976 were unusually high and variable. Attempts were made to incorporate these years into early forms of the model; however, it was finally determined that no variable could be developed to account for the tremendous atypical surges in demand during those years and the decision was made to use only the period from fiscal year 1976 to fiscal year 1983. Thus, the time frame of the data included in the final regression model was limited to eight years. Since four observations existed for each year (one each for the Army, Navy and Marines, Air Force, and other), sufficient observations existed to allow for statistical reliability.

In obtaining the data base used to build the model, much of the information sought was not readily available. Also, sufficient time did not exist for exhaustive research to be completed. Many of the data gathering problems encountered were due to this being the first study to research the demand for MAC services. An example of this problem was the lack of data aggregated at the command levels of the respective services, which would have served to increase the number of data points included in the model. Since data at that level was inaccessible, aggregated service data was relied upon.

Model Variables

As previously shown in Chapter III, construction of a model to estimate the price elasticity of demand must take into account the difference between a change in the quantity demanded and a change in demand. The MAC tariff rate captured the effect of changes in quantity demanded. Changes in demand were controlled for by introducing into the equation variables for the price of sealift, overseas manning, and the services' operating budgets for airlift. In order to control for the changing purchasing power of the dollar, all of the dollar denominated variables were deflated to 1972 equivalents by dividing them by the Gross National Product (GNP) implicit price deflator (17:225). This deflator is the standard index of choice for adjusting dollars to a common measure of overall purchasing power. Each of the variables used in the model will be explained in detail.

Dependent Variable (MTM or ETM). Demand for MAC airlift in ton-miles was the dependent variable and is analogous to the quantity variable in the elasticity equation. The ton-miles shipped by each service were obtained from HQMAC/ACIB (35), and are presented in Table VI for the years 1976 through 1983.

Airlift Tariff Rate (PAIR). The historical tariff rates for fiscal years 1976 through 1983 are shown in Table VII. As can be seen, fiscal year 1980 contained two distinct tariff rates, each being in effect for six months of the fiscal year. Because both rates were in effect for the same

TABLE VI

Channel Ton-Miles Shipped on MAC - By Service
(in millions)

Year	Total	Army	Navy/ Marines	Air Force	Other
1976	983.3	209.6	243.0	507.4	23.3
1977	853.4	279.0	189.4	351.7	33.3
1978	905.4	301.0	200.9	358.7	44.8
1979	908.2	297.7	209.5	358.3	42.7
1980	920.9	292.8	235.4	354.9	37.8
1981	980.6	316.1	266.1	355.5	42.9
1982	986.4	324.3	249.3	372.6	40.2
1983	925.5	293.7	237.8	358.9	35.1
Avg	933.0	289.3	228.9	377.2	37.5

length of time, an average of the two rates was used as the actual tariff for that year.

The deflated tariff rates for the study years are also presented in Table VII. As discussed in Chapter III, the deflator of choice was the implicit price deflator for the Gross National Product because it measures the overall purchasing power of the dollar. This deflator is shown in Table VIII for the years 1976 through 1983. The base year for this deflator is 1972.

TABLE VII

MAC Tariff Rates 1976 - 1983

Year	Tariff	Averaged Tariff	Deflated Tariff
1976	0.316053	--	0.2388189
1977	0.279988	--	0.1999200
1978	0.279988	--	0.1861375
1979	0.337386	--	0.2064533
1980	0.363670 0.497319	0.431843	0.2417392
1981	0.591566	--	0.3025758
1982	0.670675	--	0.3244992
1983	0.670675	--	0.3110305
Avg	0.44272718		0.2513968

(23)

TABLE VIII

Implicit Price Deflators for the Gross National Product
(1972 = 100.0)

Year	GNP Deflator
1976	132.34
1977	140.05
1978	150.42
1979	163.42
1980	178.64
1981	195.51
1982	206.88
1983	215.63

(17:225)

A graph of the undeflated and deflated tariffs (Figure 8) shows the importance of bringing all dollar figures to a common point of reference and is presented to clarify the true increase in the price of airlift per ton-mile once inflation effects have been removed.

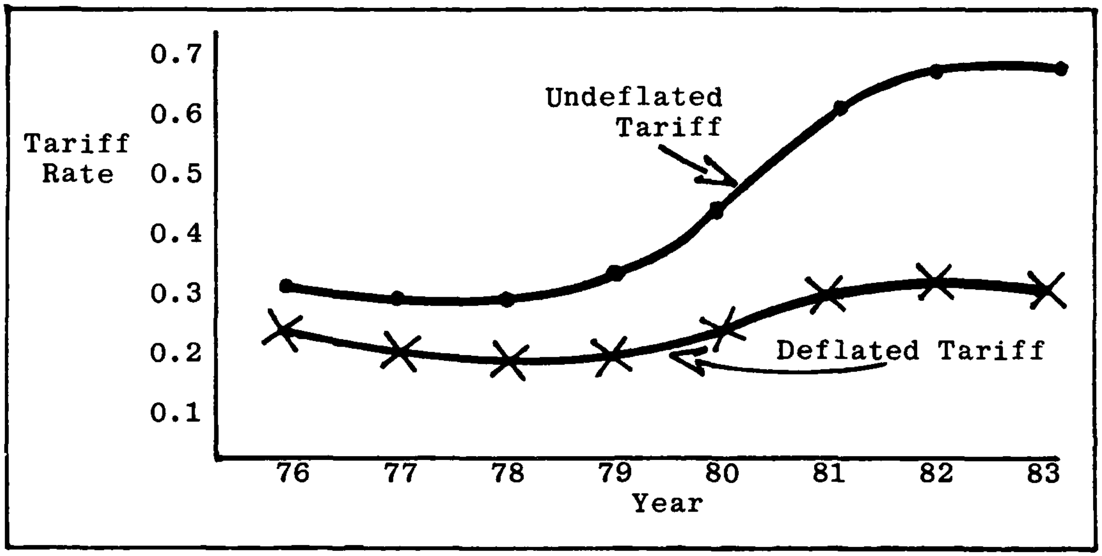


Figure 7. Deflated and Undeflated Tariff Rates, 1976-1983

<u>Sealift Tariff Rates (PSEA)</u>. The price of sealift was included in the regression equation because it is a possible substitute for airlift. It was expected that the higher the price of sealift, everything else the same, the greater would be the quantity of cargo shipped by air.

The best measure of the price of sealift available was the implicit price deflator for national defense sealift cargo movement supplied by the Department of Commerce (21).

This deflator is a price index for sealift prices in the standard unit of purchase (measurement tons) and gives a measure of actual price changes from year to year. The base year for this deflator is also 1972.

The price of sealift was then deflated by the implicit price deflator for the Gross National Product in order to obtain a variable which measured changes in the "real" price of sealift relative to the 1972 purchasing power of a dollar. Both the undeflated and deflated tariff variables are shown in Table IX.

Table IX

Sealift Cargo Movement Tariff Rates
(measurement tons)

Year	Tariff	Deflated Tariff
1976	172.4	1.302705
1977	189.3	1.351660
1978	197.9	1.315649
1979	232.0	1.419655
1980	270.6	1.514778
1981	291.9	1.493018
1982	277.1	1.340720
1983	251.4	1.165886
Avg	235.3	1.3630089

(21)

Overseas Manpower Levels (MAN). This research used overseas DoD manpower levels as an indicator of the amount of transportation support required on a regular basis for a year and as is the analogous to the concept of consumer taste. It was theorized that as manpower levels in overseas areas increased, a greater demand would be placed on airlift to sustain higher levels of supply necessary to support troops and their equipment. This independent variable, as shown in Table X, has increased over the period 1976 through 1983.

TABLE X

Overseas Manpower Levels
(by service)

Year	Totals	Army	Navy/ Marines	Air Force	Other
1976	452,413	235,099	108,552	99,989	8,773
1977	469,229	242,412	113,247	104,305	9,265
1978	480,542	244,679	121,333	105,862	8,668
1979	467,488	245,172	105,850	107,402	9,064
1980	498,459	257,874	118,769	112,083	9,733
1981	602,199	258,594	129,043	114,187	10,375
1982	538,868	267,138	143,180	118,116	10,434
1983	530,706	264,420	131,402	123,695	11,189
Avg	504,988	251,924	121,422	110,705	9,688

(28:59-60)

Operating Budget (OPRBUDG). As described in Chapter III, the operating budget is the amount of money approved by Congress for each service to use to pay for airlift cargo movements. This variable was included in the model as a representation of income. The expectation was that the more "income" or dollars available to be spent on airlift, the more airlift which would be purchased. The operating budget was deflated using the implicit price deflator for GNP listed previously in Table VIII. Both the undeflated and deflated operating budgets are listed in Tables XI and XII, respectively.

TABLE XI

Undeflated Operating Budget Approved by Congress
(in millions)

Year	Totals	Army	Navy/ Marines	Air Force	Other
1976	341,300	73,400	89,700	172,500	5,700
1977	288,300	76,500	71,500	119,800	20,500
1978	287,300	86,600	58,700	132,500	9,500
1979	324,100	95,100	72,400	141,000	15,600
1980	330,100	102,100	74,800	137,400	11,800
1981	562,900	178,700	131,200	231,200	21,800
1982	700,300	203,000	209,500	265,000	22,800
1983	712,100	187,700	207,500	290,700	26,200
Avg	443,300	125,388	114,912	186,262	16,738

(23:3)

TABLE XII

Deflated Operating Budget
(in millions)

Year	Totals	Army	Navy/ Marines	Air Force	Other
1976	257,900	55,500	67,800	130,300	4,300
1977	205,700	54,600	51,000	85,500	14,600
1978	191,000	57,600	39,000	88,100	6,300
1979	198,300	58,200	44,300	86,300	9,500
1980	184,800	57,200	44,100	76,900	6,600
1981	287,900	91,400	67,100	118,300	11,100
1982	338,800	98,200	101,400	128,200	11,000
1983	330,100	87,000	96,200	134,800	12,100
Avg	249,300	69,960	63,900	106,050	9,438

The Model

The variables presented above were incorporated into a multiple regression model in both linear and log/log form. As previously stated, both these forms of the multiple regression model are common to economic research, and both were used to verify the hypothesized relationships between the dependent variable (MTM) and each independent variable. Since the multiple regression model implicitly controls for the effects of each independent variable, it was possible to establish the separate relationships between each independent variable and the dependent variable. In each case, the hypothesized relationships between the dependent variable and the independent variables were observed. The two specifications of the model are shown below:

$$\text{(1)}\quad MTM = PAIR, PSEA, MAN, OPRBUDG \qquad (4)$$

$$\text{(2)}\quad \log(MTM) = \log(PAIR), \log(PSEA), \log(MAN), \log(OPRBUDG) \qquad (5)$$

where

MTM	=	total million ton-miles
PAIR	=	price of air cargo movements
PSEA	=	price of sealift
MAN	=	overseas manning
OPRBUDG	=	Congressionally approved operating budget

The relationship between the price variable (PAIR) and the dependent variable, quantity (MTM), was expected to be negative due to the law of demand. As shown in Chapter III, an increase in price should cause a decrease in the quantity demanded. This was the case in both specifications of the model. In the case of the sealift variable (PSEA), which is a substitute good for airlift, the expected positive relationship was observed. A positive relationship was hypothesized because when sealift becomes relatively more expensive than airlift, there should be a shift to airlift.

A positive relationship between airlift ton-miles and manning, and airlift ton-miles and operating budget was also hypothesized and observed.

Multiple Regression Output

The two specifications of the model produced R^2 values of 0.941 and 0.973 for the linear and log/log forms respectively. These results indicate that the models closely explained any variations in the dependent variable, ton-miles. This was further corroborated by the fact that the model predicted ton-mile values with a 95 percent level of confidence, as can be seen in Table XIII. Notice that each of the 32 values fall between the upper and the lower limits of the confidence interval indicating that the model is exceptional at predicting ton-mile responses for these differing situations. These confidence intervals are for the standard error of the forecast which accounts for the variability about the estimated regression line and the uncertainty concerning the estimated regression line itself.

Both variations of the model corroborate the theorized relationships described in the sections on sealift tariff rates, overseas manpower levels and operating budgets earlier in this chapter. For both models, the coefficients of the variables all demonstrated the anticipated sign and the t-statistics of the independent variables showed a very high level of significance allowing rejection of the null hypothesis that they have no importance in explaining ton-miles shipped. The following discussion will deal with only the linear model because it is more tractable for analysis. The results of the linear model are shown in Table XIV.

TABLE XIII

Model Predictions

Obs	Actual	Predict Value	Lower 95% Predict	Upper 95% Predict
1	507.400	435.765	358.337	513.193
2	351.700	332.109	258.163	406.056
3	358.700	341.867	267.926	415.878
4	358.300	341.867	267.926	415.808
5	354.900	306.273	232.165	380.382
6	355.500	390.810	313.597	468.023
7	372.600	383.119	307.170	459.069
8	358.900	385.885	307.656	464.114
9	209.600	238.981	164.501	313.461
10	279.000	271.793	196.744	346.842
11	301.000	284.732	208.728	360.736
12	297.700	290.202	215.431	364.973
13	292.800	282.349	205.789	358.910
14	316.100	344.640	268.054	421.225
15	324.300	328.494	252.493	404.495
16	293.700	274.226	195.344	353.108
17	243.000	244.822	173.110	316.534
18	189.400	227.931	155.628	300.235
19	200.900	196.118	122.675	269.560
20	209.500	211.902	139.733	284.071
21	235.400	206.720	133.308	280.133
22	266.100	236.708	162.426	310.989
23	249.300	306.674	233.032	380.315
24	237.800	268.747	193.008	344.486
25	23.300	23.533	-51.057	98.122
26	33.300	89.090	15.011	163.169
27	44.800	66.511	-8.752	141.775
28	42.700	80.009	5.951	154.068
29	37.800	63.229	-12.363	138.822
30	42.900	33.817	-43.477	111.111
31	40.200	-5.636	-83.053	71.780
32	35.100	-21.343	-101.284	58.598

TABLE XIV

Regression Results

Dependent Variable	STAT	Independent Variables PAIR	PSEA	MAN	OPRBUDG	R^2
	coef	-659.754	161.512	0.00025	0.00308	
MTM	t-stat	-5.145	2.749	3.101	15.810	.941
	B-coef	-0.259	0.132	0.171	0.935	

As can be seen, the variable for the price of airlift has a strongly negative coefficient with a t-statistic of -5.145. This t-statistic value represents a level of significance of 0.5 percent which means that only five times out of one thousand would we expect to observe the estimated results when, in fact, the true coefficient equals zero. The negative sign of this coefficient means that an increase in the airlift tariff rate will cause a decrease in million ton-miles moved. The negative Beta coefficient standardizes the unit of measure for each variable so that the size of the coefficient indicates the relative importance of that variable in explaining airlift ton-miles.† Thus, the price of airlift is approximately one-fourth as important as the operating budget. The regression coefficient of -659.754

†The Beta Coefficient =

$$\begin{pmatrix}\text{regression}\\ \text{coefficient}\end{pmatrix} \times \left(\frac{\text{standard error of dependent variable}}{\text{standard error of independent variable}}\right)$$

implies that if the deflated or "real" tariff rate goes up by ten percent from its 1976-1983 average of 0.251397, ton-miles moved would decrease by 7.12 percent from its 1976-1983 average of 932.96.

The price of sealift had a positive coefficient and a t-statistic of 2.749 which is significant at the one-percent level. It also had a Beta coefficient of 0.132. The coefficient of the sealift price variable is 161.512 which implies, for instance, that for a ten percent increase in the real price of sealift from its 1976-1983 average of 1.3627, there would be a corresponding rise in the number of million ton-miles shipped by airlift of 9.4 percent from its 1976-1983 average of 932.96 million ton-miles.

Overseas manpower has a positive coefficient of 0.00025, a Beta coefficient of 0.1707, and a t-statistic of 3.101 which is significant at the .05 percent level. The prediction is that a ten percent increase in manning from its 1976-1983 average of 493,739 would cause an increase in ton-miles shipped of 12.34 million or 1.3 percent.

The operating budget variable has a coefficient of .00308 and is significant at the .01 percent level. The Beta coefficient for this variable, 0.9348, shows that it is very important in explaining million ton-miles shipped. If there is an increase in the total services' operating budgets of ten percent, the number of million ton-miles shipped will go up to 1009.75 from the 1975-1983 average of 932.96 million. This is an increase of 8.23 percent.

Elasticity Coefficient

The regression model results implied (when evaluated at the means) inelastic demand for airlift with an elasticity coefficient of -0.7112. For the log/log case, the elasticity estimate was -0.54. This indicates that within a certain range, MAC could raise their tariff rate and at the same time increase total revenue.

As described by Douglas Bohi (10:21), the price elasticity in a linear regression is obtained by multiplying the coefficient of the price variable by $\overline{P}/\overline{Q}$, where $\overline{P}$ equals the average value of the price variable and $\overline{Q}$ is equal to the average value of the quantity variable.† The elasticity estimate then applies only the point on the demand curve equal to $(\overline{P},\overline{Q})$.

For a logarithmic regression equation, the price elasticity is equal to the coefficient of the price variable.§ A consequence of the log/log specification is that the estimated demand curve has a constant price elasticity of demand at any point on the curve. Since the interest here is in

†Since the regression coefficient equals $\Delta Q/\Delta P$, multiplying by $\overline{P}/Q$ results in $(\Delta Q/\overline{Q})$ / $(\Delta P/\overline{P})$ which is the elasticity formula.

§The regression coefficient in the log case is equal to $\Delta\log Q / \Delta\log p$ but since $\Delta\log q = \Delta q/q$ and $\Delta\log p = \Delta p/p$, the regression coefficient itself equals the price elasticity.

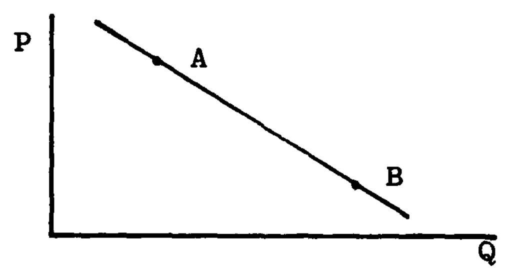
studying the elasticity of demand at various points on the demand curve, we have concentrated on the linear specification of the equation, thus allowing for the more realistic assumption that elasticity varies over different ranges of the demand curve.†

Applying the Model

The important question is: What is the estimated impact of possible change in the tariff rate upon MAC revenues? As shown, the estimated equation can be used to predict the effect of specific changes in the independent variables on MAC's total revenue. This general equation is

$$Y = B_0 + B_1 X_1 + B_2 X_2 + B_3 X_3 + B_4 X_4 + e \qquad (6)$$

†For a linear demand curve, elasticity varies at different points on the curve. With respect to the diagram below, elasticity measured at point A will be more elastic than at point B.



This is because elasticity equals the percentage change in quantity divided by the percentage change in price. For any small movement from point A there will be a large percentage change in quantity and a smaller percentage change in price than when there is an equal movement (unit change) taking place with respect to point B. There, because we are dealing with percentages, the situations are exactly reversed.

where

Y = predicted ton-miles
X_1 = PAIR

X_2 = PSEA

X_3 = MAN

X_4 = OPRBUDG

When this linear equation was estimated using the MAC data presented earlier in this chapter, the following results were obtained (see Table XIV):

$$Y = -44.8 - 659.754\ X_1 + 161.512\ X_2$$
$$+ .00025\ X_3 + .003085\ X_4 \qquad (7)$$

One important application of this demand equation is in the prediction of the effect of an increase or decrease in the ASIF tariff rate on MAC revenues.

For example, assuming the other variables are constant, if the 1983 deflated (real) tariff rate is increased by ten percent (from 0.3110305 to 0.3421336), what will be the effect on ton-miles shipped (projected ton-miles) and thus, on total revenue? The first step is to input the data into the equation:

$$\text{Projected ton-miles} = -44.8 - 659.754(.342134)$$
$$+ 161.512(1.1659) + .00025(\text{MAN}) + .003085(\text{OPRBUDG}) \qquad (8)$$

where

$$MAN = \text{the overseas manning for one service}$$
$$OPRBUDG = \text{the operating budget for one service}$$

When each service's projected ton-miles are computed, they can be added together for a total projected ton-mile figure and multiplied by the tariff rate to get an estimated total revenue figure. (For calculations, see Appendix B). The results of this calculation were

$$\text{Total Revenue} = 820.8959 \text{ million ton-miles X } \$.342134$$
$$= \$\ 280.8561 \text{ million} \qquad (9)$$

The regression equation predicts that if (everything else constant) the real tariff rate in 1983 had been ten percent higher, MAC revenues would have been $280.853 million, which is $.003 million higher than they actually were.

In order to assess the impact of alternative real tariff rates on MAC revenues, the estimated regression equation was used to predict air ton-miles as a function of the price of airlift with all other variables held constant at their 1983 levels. The results are displayed in Table XV. Notice that in response to higher tariff rates, even as the number of predicted ton-miles decreases, the overall total revenue goes up. This relationship continues until the rate increases to approximately five percent above the 1983 real tariff rate. At that point, total revenue begins to decrease. As can be seen, total million ton-miles continually goes down as the

TABLE XV

Revenue Computations

Hypothetical Real Tariff Rates as % of Real 1983 Tariff Rate	Predicted Ton-Miles	Total Revenue in Real Dollars	Change in Total Revenue in Real Dollars	ARC Elasticity Coefficient
90%	985.059	275.745		
			+.741	- .757
91%	976.851	276.486		
			+.689	- .772
92%	968.642	277.175		
			+.639	- .787
93%	960.434	277.814		
			+.587	- .802
94%	952.226	278.401		
			+.536	- .818
95%	944.018	278.937		
			+.486	- .834
96%	935.810	279.423		
			+.434	- .850
97%	927.602	279.857		
			+.383	- .867
98%	919.394	280.240		
			+.332	- .883
99%	911.186	280.572		
			+.281	- .900
100%	902.976	280.853		
			+.231	- .918
101%	894.769	281.084		
			+.178	- .935
102%	886.561	281.262		
			+.128	- .953
103%	878.353	281.390		
			+.077	- .972
104%	870.145	281.467		
			+.026	- .990
105%	861.937	281.493		
			-.025	-1.009
106%	853.729	281.468		
			-.077	-1.029
107%	845.521	281.391		
			-.127	-1.049
108%	837.312	281.264		
			-.178	-1.069
109%	829.104	281.086		
			-.230	-1.089
110%	820.896	280.856		

price of airlift increases. This price/quantity information is plotted in Figure 8. This curve, called a demand curve, is in concert with the economic principle that demand decreases with higher prices, hence the negative slope. The figure is labeled according to the areas of elastic, unitary, and inelastic demands. Corresponding to those areas, the point at which total revenue will begin to decline is the next price above that which gives unitary elasticity.

The ranges of demand elasticity have also been identified in Figure 8. Although elasticity is defined mathematically with respect to infinitesimally small changes in price and quantity, its value over a given range can be estimated by using the formula for "arc elasticity" which is:

$$\eta_{arc} = \frac{\dfrac{(Q_1 - Q_2)}{(Q_1 + Q_2)/2}}{\dfrac{(P_1 - P_2)}{(P_1 + P_2)/2}} \qquad (10)$$

where

P_1 = the original price

P_2 = the new estimated price

Q_1 = quantity demanded at P_1

Q_2 = quantity demanded at P_2

The results of the arc elasticity calculations for the demand curve shown in Figure 8 can be found in Table XV. It is evident from this table that the computed arc elasticities do

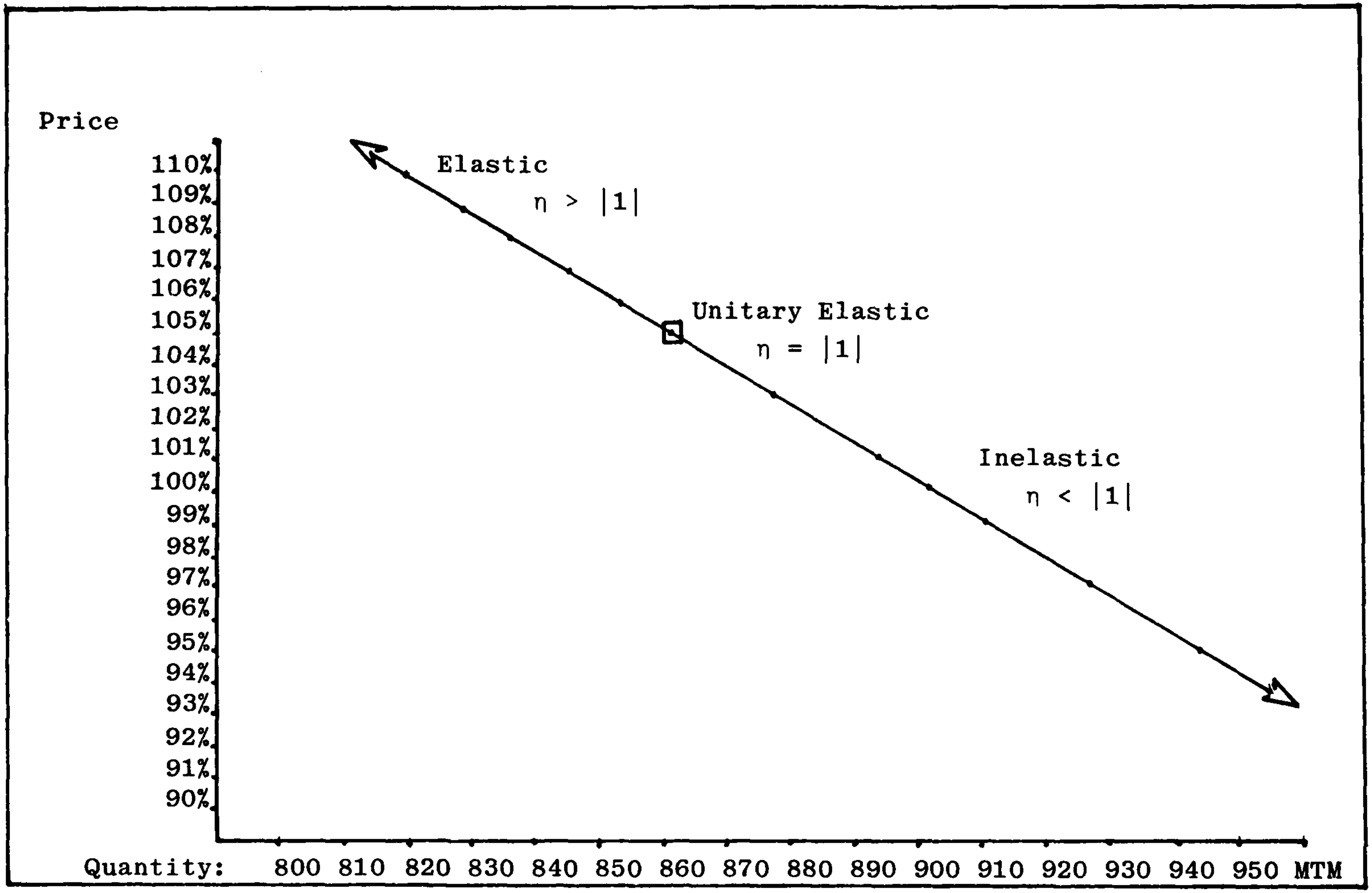


Figure 8. Predicted Demand Curve for MAC Airlift at Specified Tariff Rates

correspond with the anticipated demand/price/total revenue relationships.

It is also instructive to examine the graphical relationship between price and total revenue, as shown in Figure 9. Note that the maximum revenue is obtained at a tariff which is 105 percent of the real 1983 tariff. This is because at that tariff rate the point of unitary elasticity is approached.

In the Chapter III definition of price elasticity of demand, it was shown how, in an inelastic relationship, an increase in price would produce a decrease in demand, but an increase in total revenue up to the point of unitary elasticity. At that point, an increase in price would still result in a decrease in demand -- but total revenue would remain the same. As price continues to increase, one moves past the point of unitary elasticity and into the range of elasticity, where an increase in price would not only cause a decrease in demand, but a decrease in total revenue. These relationships are once again shown below:

P	TR	E
$\uparrow$	$\uparrow$	inelastic, $E < \|1\|$
$\uparrow$	same	unitary elastic, $E = \|1\|$
$\uparrow$	$\downarrow$	elastic, $E > \|1\|$

As seen in Figure 9, the ranges of inelastic, unitary, and elastic demand are labeled so that the price/total revenue relationship can be more easily visualized. Note

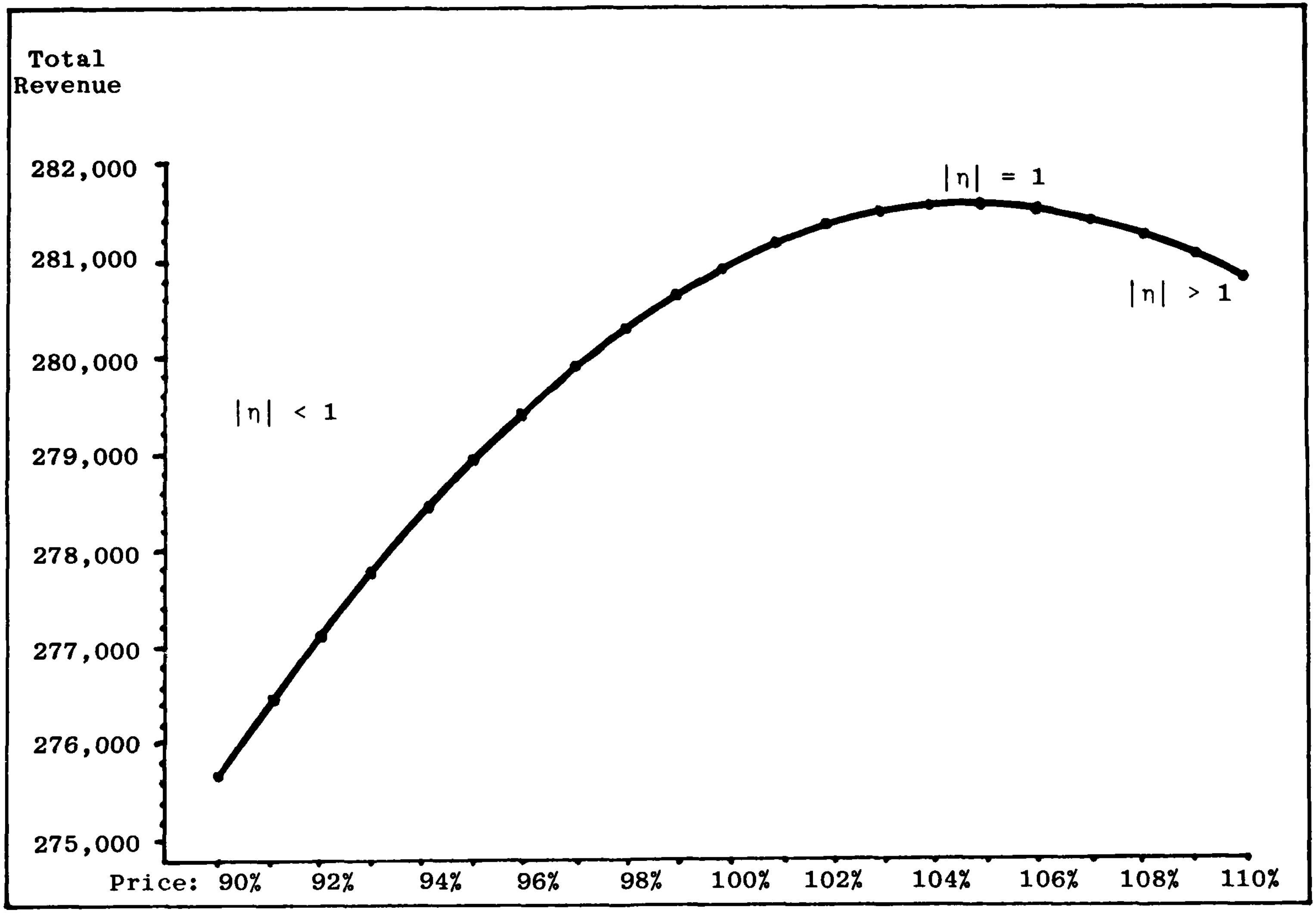


Figure 9. Total Revenue at Specified Tariff Rates

price increases from 90 to 105 percent of the 1983 real (deflated) tariff rate, an increase in total revenue is exhibited. This is caused by these price/total-revenue point pairs being in the inelastic range of the demand line (Figure 8). The inelastic relationship, as seen by the positive slope of the curve, means that even though demand goes down when the tariff rate rises -- the total revenue increases; thus there is, as expected, a greater percentage increas in price than there is a percentage drop in total revenue.

As total revenue approaches the unitary elasticity point the curve levels off, indicating that the percentage drop in demand (quantity) is beginning to off-set the effects of increased price. When the changes become equal, the slope equals zero and the point of unitary elasticity is reached. However, as one moves past this point, there is a decrease in total revenue.

This decrease is caused by the relationship between price and demand reaching the elastic range of the demand curve which means that the percentage change (decrease) in demand is greater than the percentage increase in price. Thus, the total revenue goes down. This has great significance for MAC pricing policies because they would not want to price the tariff in the elastic range if they wish to preserve aircraft cargo capacity utilization or to maintain the position of the ASIF.

Figures 8 and 9 graphically demonstrate the usefulness of this model to MAC planners. Figure 9 is especially applicable because, whatever the tariff policy, this chart will show the effects of that policy on the total revenue received. The resulting capability to quickly assess the overall effectiveness of an airlift tariff rate change on aircraft utilization and total revenue can be invaluable. Also, the model is not restricted to employment with air rate changes. It also can serve to demonstrate the effects of changes in the other variables included in the model, such as described earlier.

When performing or following this analysis, the reader should bear in mind that we have been dealing with deflated (real) tariff rates. Thus, if the tariff rate for the coming year were to increase by three percent and the GNP deflator by seven percent, the real tariff rate will have dropped by four percent.

In addition, it must be recalled that this analysis has proceeded under the assumption that all other variables are held constant, thus measuring the effects of changes in quantity demanded on total revenue. However, if one wanted to measure changes in demand caused by factors other than the price variable, this could also be done. For example, the aforementioned 1983 MAC study projects a yearly two percent increase in demand for airlift. This increase is based purely on growth, and is unrelated to any changes in MAC tariff rates. Thus, the increase exemplifies a shift in the demand curve away from the origin (a change in demand). If this change in demand was combined with the change in quantity demanded, as computed from some increased tariff level, a new total revenue figure could be calculated to predict the combined effect. Graphically, what would have occurred, would be a move from point A to point B (accounting for a change in the quantity demanded) caused by the tariff increase and a simultaneous outward shift of the demand curve, caused by the two percent increase in demand unrelated to any price fluctuation (accounting for a change in demand). This concept is demonstrated in Figure 10.

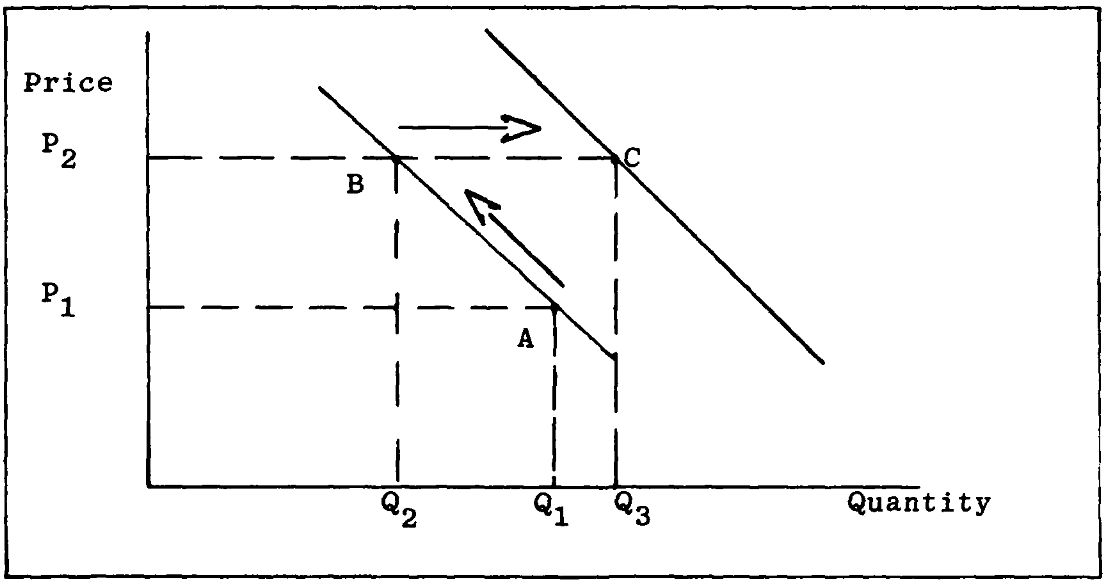


Figure 10. Change in Quantity Demanded (A to B) and a Change in Demand (A to C)

A good illustration of this concept is available in the data presented in Tables VI and VII. For example, in the years 1978 and 1979, both ton-miles shipped and the airlift tariff rate increased. This does not indicate that there is an upward sloping demand curve; it is just an indication of there being a change in demand that year, as illustrated in Figure 10.

To demonstrate how this works, remember from Figure 8 how the data showed that, everything else held constant, the quantity of ton-miles shipped dropped as the price went up. In numbers then, if the real tariff rate increased from the 1983 rate of 0.311 (P_1 in Figure 10) up to 0.4 (P_2 in Figure 10), when estimated by the regression equation, the predicted number of ton-miles shipped will drop from 903.058 (Q_1 in Figure 10) to 668.186 (Q_2 in Figure 10) million ton-miles. This means that there is a corresponding drop in predicted total revenue received from the 1983 level of $280.851 million down to $267.274 million. Therefore, the response to the tariff increase follows the downward sloping demand curve, illustrating the classic change in the quantity demanded where the response is elastic.

However, what happens if there is a corresponding shift (increase) in demand which is totally unrelated to the shift in the price variable? This is a realistic question because MAC estimates that with mission changes and increases in time-sensitive cargo movements, there will be a two percent increase in demand for cargo airlift each year, regardless of price fluctuations. This could cause total revenue at Q_3 to increase above the Q_1 total revenue amount, thus causing the appearance of an upward slope in the demand curve, although in reality what has occurred is a corresponding change in quantity demanded and change in demand.

For example, arbitrarily using a ten percent increase in demand and factoring it into the previous calculations, the predicted quantity demanded (Q_3) goes up from 668.18 to 749.298 million ton-miles. Because of this increase, the total revenue at point C in Figure 10 becomes higher ($299.719 million) than it was at point A with the original tariff rate ($280.851 million).

The preceding example demonstrates how a change in demand can offset a change in the tariff rate, even when the increase in price brings demand into the elastic area of the demand curve. This can be useful information when making tariff rate policy.

This regression model, then, accomplished the task for which it was designed: the visualization of the effect of rate changes on the total revenue that the ASIF receives. However, it must be remembered in future applications of this model that the regression equation was based on certain assumptions which may no longer be relevant.

First, the model was based on four important variables; nevertheless, these may not be the only variables of import. Other effectors may also have a strong effect on demand.

Next, the policy underlying this model could change drastically, causing the model to no longer be appropriate. Also, a large change in one of the variables, such as overseas manpower levels, could require the model to be modified.

In summary, it is always difficult to forecast over long periods without updating the forecasting model. This model has proven to be a viable method of predicting demand levels accurately due to well-defined variables. In the future, new and updated versions of this regression model may be advantageous given an ever-changing Military Airlift Command operating environment.

V. Conclusions and Recommendations

Conclusions

Implications of the Results. This research has investigated the relationship between the ASIF tariff rates, sealift tariff rates, overseas manpower levels, and the operating budgets of the services and the resulting demand for MAC airlift. The particular emphasis in this research was on quantifying the impact of changes in the price of airlift upon the demand for airlift and, thus, on the total revenue MAC receives for their channel cargo services. The estimates imply that the pricing policy for maximizing total revenue would set the tariff in real terms at a five percent higher level than that of the 1983 tariff rate. Any tariff level set above this point would serve to decrease total revenue while any lower tariff would also decrease revenue, but would increase utilization. Although this research does not consider the issue of how the optimal tariff rate should be determined, the model presented herein has been developed for assessing the revenue impacts of any given MAC tariff rate.

These findings have added significance when it is recalled that, as related in Chapter II, in the next ten to fifteen years MAC will undergo significant growth in organic capacity, and thus increased system operating costs will occur. Under the operating rationale for industrially funded activities, this influx of capacity will precipitate a need to increase total revenue in order to cover these costs and trends toward a zero profit/zero loss position in the ASIF. Since only that portion of the demand curve, up to a five percent increase in the 1983 tariff level, is contained in the inelastic region, increases in excess of five percent will only serve to decrease total revenue. Any future MAC pricing policies must be cognizant of this relationship and what it implies.

If demand had been found to be elastic with respect to price, then policies designed to make the tariff more competitive (i.e., lower) could have increased demand while at the same time increasing revenues. But since the opposite is implied by the research results (inelastic), a lower tariff would succeed in increasing demand while concurrently decreasing total revenue.

Although the impact of the additional organic capacity to the MAC fleet cannot at this time be quantified, several conclusions can be be reached regarding the effect on the MAC year-end zero balance goal. If policy, dictating a trend toward a zero profit/zero loss position for the ASIF is continued in future years, the introduction of increased capacity into the system will force MAC to spread vastly increased system operating costs over a relatively stable ton-mile demand, thus forcing an increased tariff rate to

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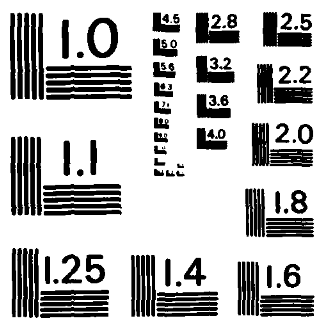

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

cover operating costs. The findings of this research indicate an increased tariff level will only serve to eventually shift the price/quantity point on the demand curve past the point of unitary elasticity and into the elastic range. If this occurs, total revenue will begin to decrease, resulting in a negative year-end position for the ASIF, and thereby forcing tariff increases in the following years to make up the loss.

Such a trend of increasing tariff rates to cover operating costs could cause movement away from airlift to a substitute good, sealift, and cause serious underutilization of MAC organic capacity, since not only would MAC system readiness costs have to be paid, but also those costs incurred by services in procuring sealift through MSC and/or commercial means. Additionally, use of CRAF contracts may have to be substantially curtailed, from their already low level, in order to minimize future ASIF losses. Such an action would serve to exacerbate an already sensitive issue in regard to the willingness with which commercial airlines view the MAC/CRAF arrangement.

<u>The "Optimal" MAC Tariff Rate</u>. In attempting to sort out the information available on the subject of ASIF pricing policies, the MAC contention that a new look must be taken at the structure under which the ASIF tariff is constructed seems reasonable. The incentive pricing programs proposed

by MAC may aid in reducing the impact of the forthcoming increases in capacity; however, the key is in the issue of what MAC terms an "economic value tariff." This tariff would set ASIF rates which are comparable to commercial rates to encourage use of organic capacity. Since the ASIF as a whole is a mechanism which insures efficient management of airlift resources, the price of that airlift should not be set at such a level as to drive potential demand to substitute modes. Any tariff rate derived where the quantity demanded equals the quantity supplied serves to ration the available supply to those who value it the most, thus putting MAC capacity to its best possible use.

Due to the inelastic demand found in the model, a lowering of the tariff rate would decrease total revenue, increase demand, and therefore increase overall utilization of MAC assets, and theoretically curtail the movement of air-eligible cargo to surface modes and thus minimize DoD dollars spent outside the DoD system. This overall decrease in total revenue could imply huge losses for the ASIF; however, even if this were the case, the real cost to the Air Force would remain basically unchanged because MAC should, in reality, be considered a fixed cost. The O&M funding of this expected loss could allow the setting of tariff levels which would encourage greater utilizaton of organic capacity.

Based on the research presented, the authors support MAC's efforts to institute a competitive, economic value tariff to encourage an increase in demand and thus, system utilization. These objectives realistically address the goals and intent of the Military Airlift Command. Whatever the "optimal" tariff selected, this study has identified an approach which can be used to great benefit in assessing MAC revenues and funding requirements.

Recommendations for Future Study

Because no previous study has been conducted in the area of price elasticity of demand for MAC airlift and because this is an area of continuous high level interest where there are frequent pricing policy changes, there are a large number of possible extensions to this research.

The first area of importance is the refinement of this model through the use of less aggregated data. The use of data from each service's headquarters as opposed to that from the combined services could significantly improve the prediction capability of the model and will also allow a much broader range of experimentation with the data.

Examples of uses of the less aggreaged data are:

(1) A comparison of the differences between the responses of the services to changes in both the airlift and the sealift rates. There is a possibility that the reaction of each service to changes in the tariff rates would be different. These reactions could have significant implications for the ability of MAC to sustain revenues to meet the year

end zero balance requirement. Any major differences between the services could be identified through the use of separate regressions for each service and a comparison of the results.

(2) The increased number of data points available from the headquarters data would improve the prediction capability of the model by allowing a closer approximation of the true regression coefficients. This would decrease the error involved with model estimation.

Other experiments could utilize the data contained herein. This model could be used as a starting point for developing a more elaborate model which takes into account such variables as the political environment both in the United States and overseas.

Another field of investigation includes the area of policy changes and their effect on MAC operations in general. Headquarters MAC is considering a major change in their tariff policy that will alter it from the present system (one rate for all materials) to a three-tiered rate system which will give weight breaks for higher tonnage cargo. This tariff may go into effect during the next fiscal year, having been tested on one route since April, 1983. This three-level tariff would charge full rates to packages below 1500 pounds. It would charge a medium weight package slightly less, and large packages would be given a much lower tariff rate.

If this three-tiered rate is instituted, it could have significant implications on the total revenue of the ASIF and

and would require investigation using different variables than those used in this model.

The last area recommended for future study is that of the effects of CRAF funding on the ability of the ASIF method of funding to continue to support the flying hour programs as is presently required. With the ever-present pressure from the civilian carriers to receive a percentage of cargo in peacetime equal to that which they will be expected to haul during full contingency operations (forty percent of all military cargo), Congress may soon be persuaded to pass legislation of this type. At this time, the CRAF receives less than seven percent of military channel cargo. If the percentage of cargo transported by the CRAF is raised at the same time MAC is attempting to more fully utilize its ever-increasing organic lift capability, the ASIF will have to be supplemented with outside dollars. There is a great need for a study of how MAC could best handle this situation, given continued operation of the Airlift Services Industrial Fund as it is managed today.

Appendix A

MAC Tariff Rates

1 Jul 63	.139154
1 Oct 63	.129275
1 Feb 64	.133671
1 Apr 64	.114957
1 Jul 64	.129844
1 Jan 65	.168408
1 Mar 65	.190806
1 Jul 65	.148173
1 Mar 66	.120613
1 Jul 66	.115494
1 Dec 66	.146446
1 Apr 67	.179982
1 Jul 67	.120048
1 Dec 67	.092948
1 Jan 69	.094377
1 Jul 69	.093497
1 May 70	.102847
1 Jul 71	.096519
1 Jan 72	.121461
1 Jul 72	.121464
1 Jul 73	.162921
1 Jan 74	.207567
1 Jul 74	.270593
1 Jul 75	.316053
1 Oct 76	.279988
1 Oct 78	.337386
1 Oct 79	.363670
1 Mar 80	.497319
1 Oct 80	.591566
1 Oct 81	.670675
1 Oct 82	.670675

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1970	Pres. Budget					
	MTM	2253.6	772.9	1601.3	28.4	
	$	264.6	95.0	179.1	2.8	
	Oper. Budget					
	MTM	1418.5	460.8	1158.6	157.5	
	$	133.8	44.7	115.8	2.9	-26.4
	Actual					
	MTM	1351.4	460.0	1280.3	143.5	
	$	121.4	44.9	134.5	3.3	
1971	Pres. Budget					
	MTM	1832.7	498.5	1449.1	27.8	
	$	202.2	54.9	144.9	2.8	
	Oper. Budget					
	MTM	1316.8	333.2	1029.1	150.3	
	$	135.1	34.4	108.1	3.3	+10.9
	Actual					
	MTM	803.6	337.8	1087.5	188.9	
	$	90.4	42.7	127.7	6.7	

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1972	Pres. Budget					
	MTM	1224.6	268.3	712.3	69.4	
	$	112.4	24.5	62.8	1.5	
	Oper. Budget					
	MTM	721.0	334.4	973.6	198.3	
	$	83.4	38.8	119.1	6.7	-26.1
	Actual					
	MTM	669.0	371.2	1168.2	128.3	
	$	79.1	44.8	149.2	5.6	
1973	Pres. Budget					
	MTM	700.6	324.9	987.8	153.9	
	$	89.8	41.7	134.7	5.0	
	Oper. Budget					
	MTM	582.3	302.2	969.2	22.6	
	$	86.0	44.9	145.1	2.8	+42.3
	Actual					
	MTM	500.4	373.9	1152.0	14.3	
	$	73.5	53.9	178.3	2.0	

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1974	Pres. Budget					
	MTM	538.3	305.2	691.6	18.7	
	$	90.8	51.5	17.5	2.6	
	Oper. Budget					
	MTM	423.0	257.5	869.0	11.0	
	$	73.3	44.5	150.6	1.7	-53.1
	Actual					
	MTM	269.0	257.8	647.8	11.0	
	$	58.0	53.4	138.5	2.2	
1975	Pres. Budget					
	MTM	346.3	269.3	741.3	10.3	
	$	68.5	53.3	144.9	2.0	
	Oper. Budget					
	MTM	264.4	198.7	600.6	9.3	
	$	84.8	63.9	191.8	3.0	-31.6
	Actual					
	MTM	191.3	255.2	590.2	10.9	
	$	56.3	79.2	176.0	3.4	

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1976	Pres. Budget					
	MTM	214.0	250.6	442.0	10.3	
	$	72.5	87.7	146.0	3.8	
	Oper. Budget					
	MTM	205.2	251.7	500.3	15.1	
	$	73.4	89.7	172.5	5.7	+66.8
	Actual					
	MTM	209.6	248.0	507.4	23.3	
	$	70.1	86.9	175.7	8.6	
1977	Pres. Budget					
	MTM	200.1	249.6	414.6	55.1	
	$	63.0	78.9	129.4	18.7	
	Oper. Budget					
	MTM	244.9	228.5	395.4	60.4	
	$	76.5	71.5	119.8	20.5	-71.2
	Actual					
	MTM	279.0	189.4	351.7	33.3	
	$	82.3	57.3	116.5	10.4	

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1978	Pres. Budget					
	MTM	246.6	229.5	408.9	51.2	
	$	74.2	70.2	126.2	17.2	
	Oper. Budget					
	MTM	305.6	206.2	400.5	31.6	
	$	86.6	58.7	132.5	9.5	+ 7.0
	Actual					
	MTM	301.0	200.9	358.7	44.8	
	$	87.0	62.7	119.2	14.9	
1979	Pres. Budget					
	MTM	268.3	190.6	383.8	31.6	
	$	93.6	67.3	156.5	11.5	
	Oper. Budget					
	MTM	218.1	195.0	351.7	43.4	
	$	95.1	72.4	141.0	15.6	+55.2
	Actual					
	MTM	297.7	209.5	358.3	42.7	
	$	98.5	80.1	134.9	17.7	

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1980	Pres. Budget					
	MTM	290.0	178.7	358.9	43.0	
	$	96.3	63.7	140.1	15.0	
	Oper. Budget					
	MTM	290.4	185.7	339.0	30.8	-48.0
	$	102.1	74.8	137.4	11.8	
	Actual					
	MTM	292.8	235.4	354.9	37.8	
	$	125.6	124.1	181.8	20.0	
1981	Pres. Budget					
	MTM	284.0	184.1	335.5	38.9	
	$	134.3	100.2	181.5	19.9	
	Oper. Budget					
	MTM	317.3	199.8	330.1	35.9	
	$	178.7	131.2	231.2	21.8	- 1.9
	Actual					
	MTM	316.1	266.1	355.5	42.9	
	$	178.5	183.6	235.1	27.2	

Airlift Service Industrial Fund - Channel Cargo
(Dollars in Millions) (MTM = Million Ton Miles)

Fiscal Year		Army	Navy/ Marines	Air Force	Other	ASIF Year-End Status ($)
1982	Pres. Budget					
	MTM	320.0	210.4	318.9	35.9	
	$	206.0	154.0	247.6	25.0	
	Oper. Budget					
	MTM	307.4	279.3	351.7	32.0	
	$	203.0	209.5	265.0	22.8	+58.4
	Actual					
	MTM	324.3	249.3	372.6	40.2	
	$	221.1	190.0	289.1	29.0	
1983	Pres. Budget					
	MTM	307.3	282.2	360.1	32.0	
	$	202.9	211.7	272.3	22.6	
	Oper. Budget					
	MTM	296.9	275.5	372.5	35.1	
	$	187.7	207.5	290.7	26.2	+110.6
	Actual					
	MTM	293.7	237.8	358.9	35.1	
	$	207.2	179.3	269.4	25.3	

Appendix B

Calculation of Projected Million Ton Miles Moved Per Year for 1983

The estimated regression equation with 1983 tariff rates is:

$$\text{Projected MTM} = -44.8 - 659.754\ (.342134) + 161.512\ (1.1659) + .00025\ (\text{MAN}) + .00308\ (\text{OPRBUDG})$$

Because there were four separate data points representing the four service categories for each year, the data for the overseas manpower (MAN) and operating budgets (OPRBUDG) must be summed in order to compute totals for those variables to be used in the equation. This can be represented as four separate equations:

$$\text{Projected Army MTM} = -44.8 - 659.754\ (.342134) + 161.512\ (1.1659) + .00025\ (264420) + .00308\ (87047.25)$$

$$\text{Projected Navy MTM} = -44.8 - 659.754\ (.342134) + 161.512\ (1.1659) + .00025\ (131402) + .00308\ (96229.64)$$

$$\text{Projected AF MTM} = -44.8 - 659.754\ (.342134) + 161.512\ (1.1659) + .00025\ (123695) + .00308\ (134814.2)$$

$$\text{Projected Other MTM} = -44.8 - 659.754\ (.342134) + 161.512\ (1.1659) + .00025\ (11189) + .00308\ (12150.44)$$

These figures can be combined to give the total projected million ton miles shipped:

$$\text{Total Projected MTM} = -179.2 - 659.754\,(1.368536) + 161.5\,(4.6636) + .00025\,(530706) + .0038\,(330241.53)$$

$$= -179.2 - 902.897 + 753.1714 + 132.6765 + 1017.144$$

$$= 820.8949$$

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VITA

Captain Pia L. Caruso was born on 1 February 1952 in Ft. Worth, Texas and graduated from high school in San Antonio, Texas.She then attended the University of Texas at Austin from which she received the degree of Bachelor of Arts in Microbiology in May 1974, and remained there to earn over ninety graduate hours in the field. April 1978, Captain Caruso entered the Air Force Officers Training School in San Antonio and received her commission in June 1978.

After receiving transportation training, Captain Caruso served as Vehicle Maintenance Officer, Vehicle Operations Officer and Traffic Management Officer at Cannon AFB, New Mexico. While there, Captain Caruso also earned a Master of Arts in Human Relations Management from Pepperdine University. She next served at Osan AB, Korea as Traffic Management Officer. Upon her return in July 1981, Captain Caruso became the Chief of Transportation at Reese AFB, Texas. She was subsequently chosen as the Air Training Command Outstanding Transportation Officer of the Year for 1983. She remained at Reese until entering the School of Systems and Logistics, Air Force Institute of Technology, in May 1983.

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VITA

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION: UNCLASSIFIED	1b. RESTRICTIVE MARKINGS
2a. SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT: Approved for public release; distribution unlimited.
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S): AFIT/GLM/LSM/82S-9	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION: School of Systems and Logistics — 6b. OFFICE SYMBOL (If applicable): AFIT/LS	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State and ZIP Code): Air Force Institute of Technology, Wright-Patterson AFB, Ohio 45433	7b. ADDRESS (City, State and ZIP Code)
8a. NAME OF FUNDING/SPONSORING ORGANIZATION — 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State and ZIP Code)	10. SOURCE OF FUNDING NOS.: PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT NO.
11. TITLE (Include Security Classification): See Box 19	

12. PERSONAL AUTHOR(S): Pia L. Caruso, Capt, USAF and Jeff P. Eisenberg, Capt, USAF

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Yr., Mo., Day)	15. PAGE COUNT
MS Thesis	FROM ____ TO ____		117

16. SUPPLEMENTARY NOTATION

Approved for public release: IAW AFR 190-17.
14 Sept 84
LYNN E. WOLAVER
Dean for Research and Professional Development
Air Force Institute of Technology (ATC)
Wright-Patterson AFB OH 45433

17. COSATI CODES

FIELD	GROUP	SUB. GR.
05	03	
15	05	

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)

Airlift, Demand, Airlift Tariff Rates, Demand Curve, Airlift Services Industrial Fund, ASIF

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

Title: THE IMPACT OF ALTERNATIVE TARIFF RATES ON MILITARY AIRLIFT COMMAND REVENUES

Thesis Chairman: Dr. Leroy Gill

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT: UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS ☐	21. ABSTRACT SECURITY CLASSIFICATION: UNCLASSIFIED

22a. NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE NUMBER (Include Area Code)	22c. OFFICE SYMBOL
Dr. Leroy Gill	(513) 255-4845	AFIT/LSY

DD FORM 1473, 83 APR — EDITION OF 1 JAN 73 IS OBSOLETE.

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SECURITY CLASSIFICATION OF THIS PAGE

This thesis ~~research effort~~ investigated the relationship between Airlift Services Industrial Fund (ASIF) tariff rates and the resulting demand for Military Airlift Command (MAC) services in regard to channel airlift. Emphasis was placed on the economic theory of price elasticity of demand to estimate what effect different tariff rates could have on total revenue.

The analysis was accomplished using a multiple regression model and historical data from the period 1976 to 1983, inclusive. Both linear and a log/log variation of the model were used to establish the relationship between the price of MAC airlift and the actual ton-miles of cargo transported by air. This relationship was found to be inelastic up to a five percent increase in the 1983 real tariff rate. Once the estimated demand curve was established, conclusions on the continued use of current ASIF policy were discussed in light of the increase in organic capability MAC is expecting to experience in the next fifteen years.

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